Figure 1a

Figure 1b

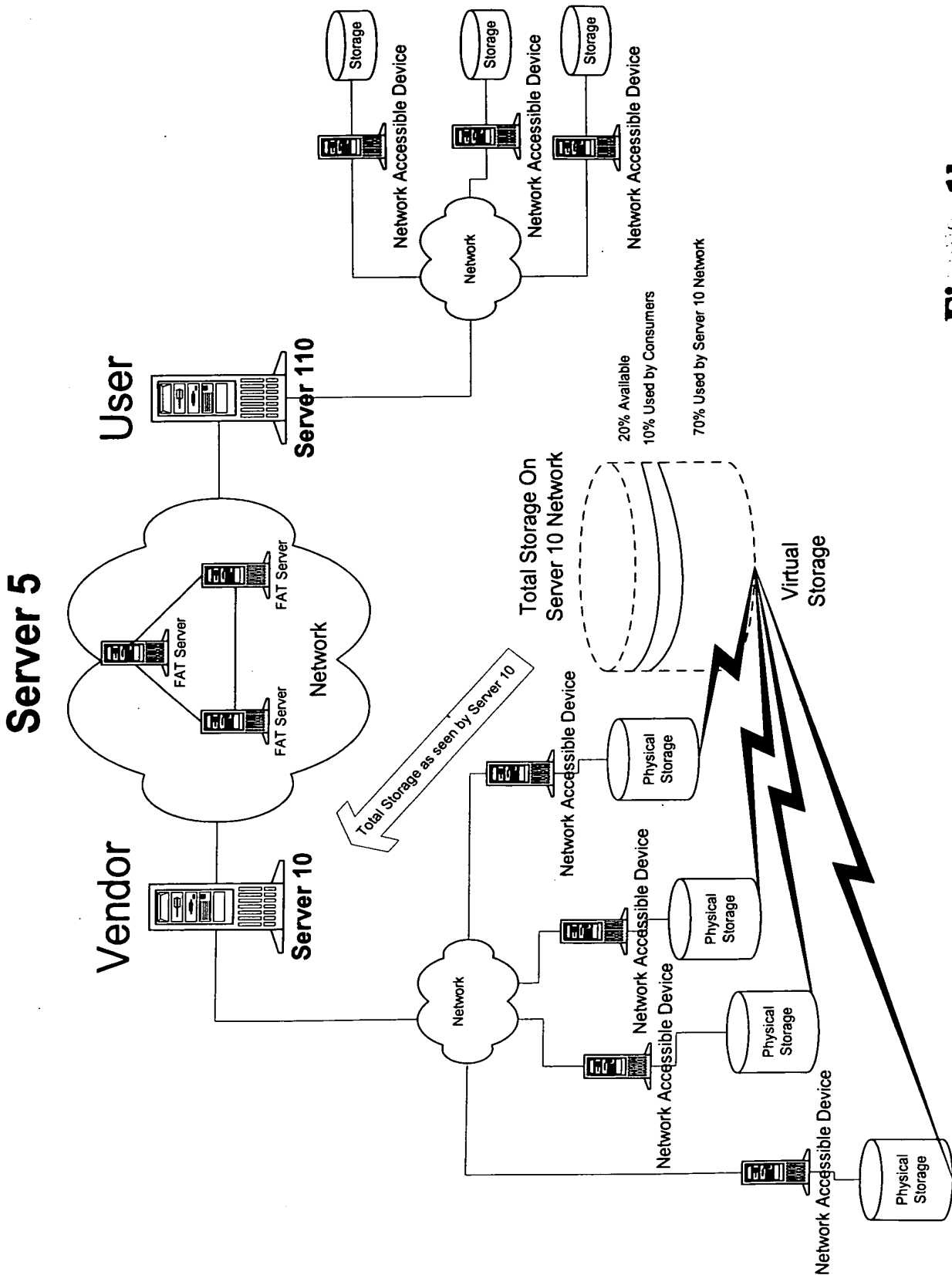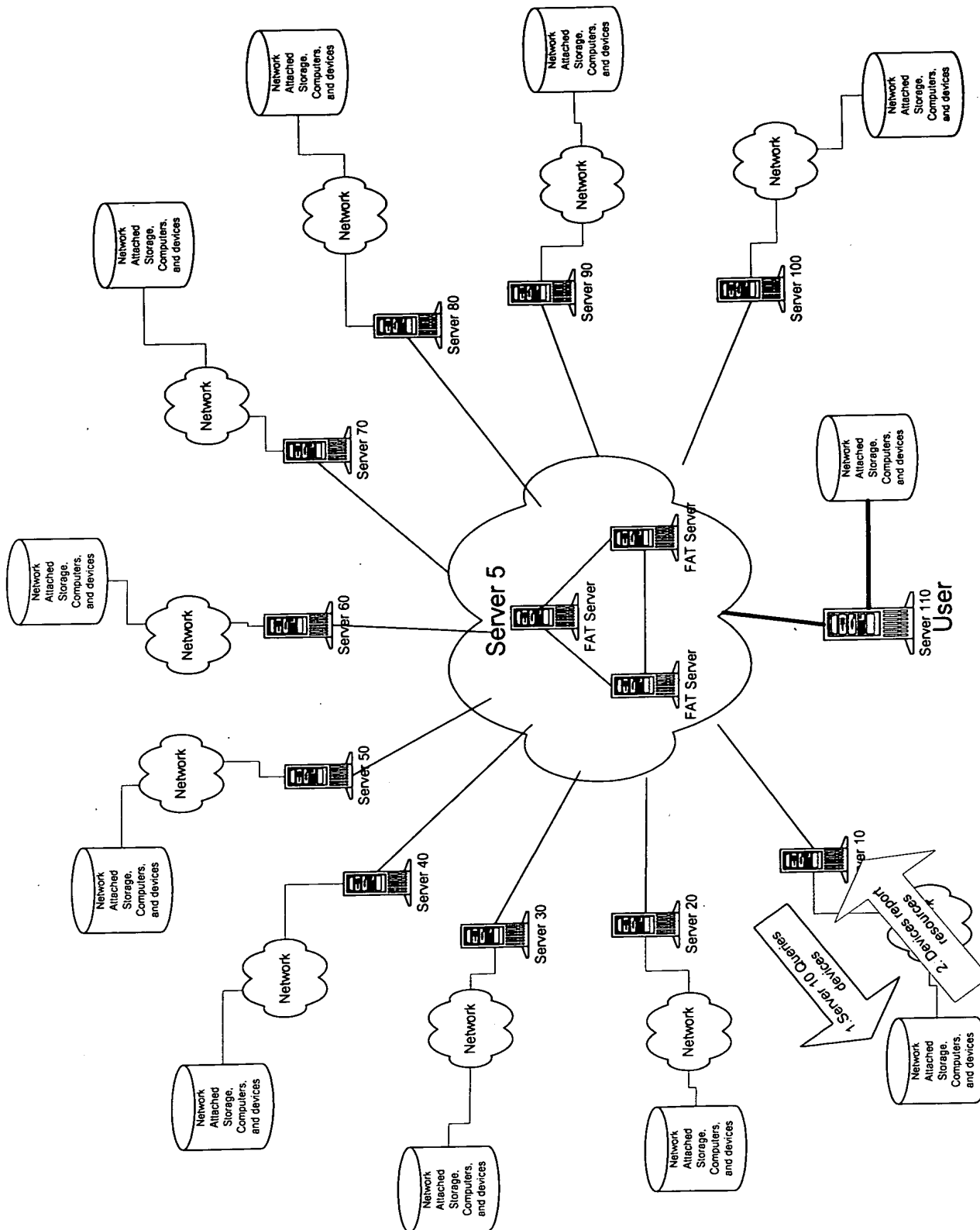**Figure 1c**

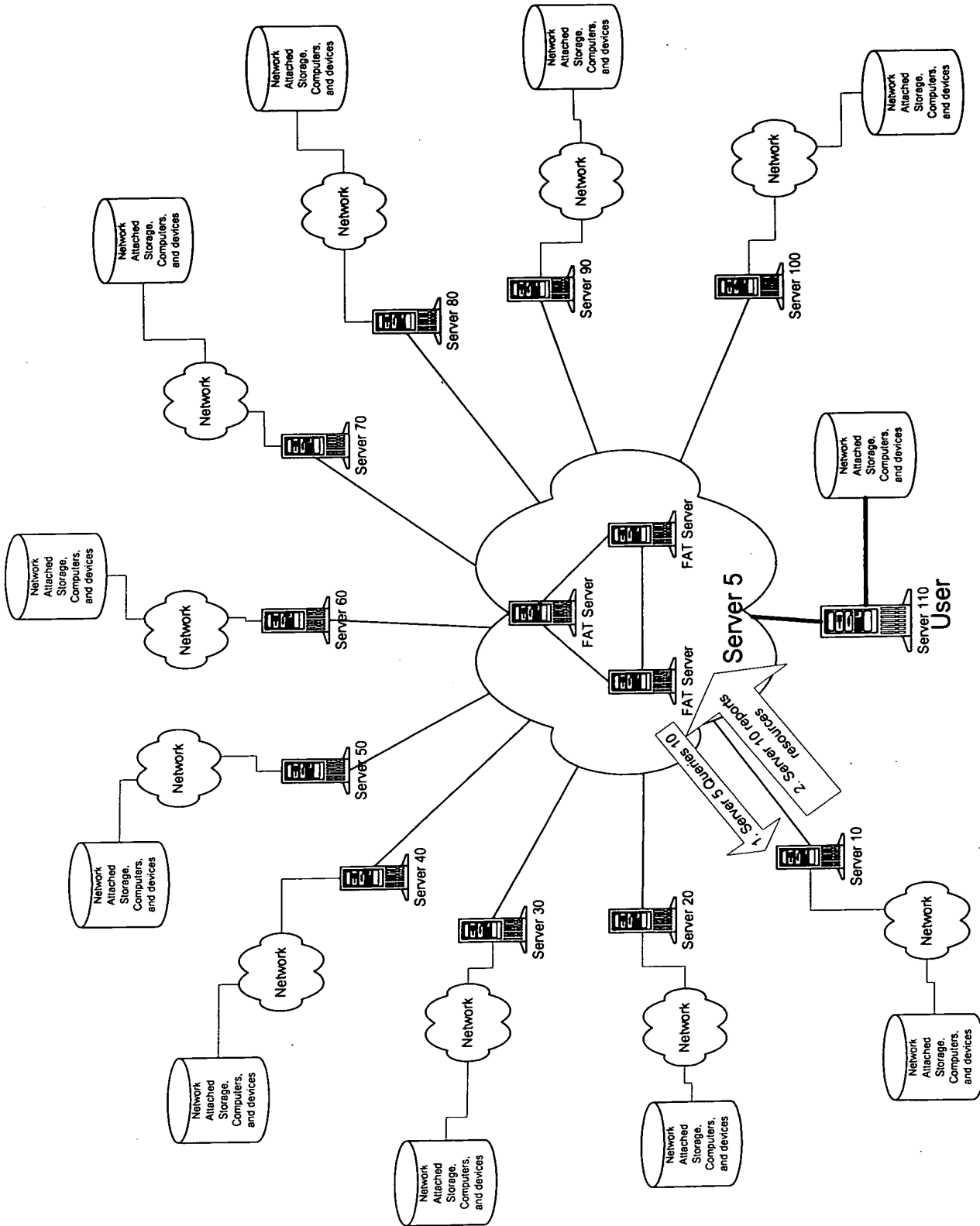Networked attached storage devices report to attached server.

Figure 2

Vendor Servers wishing to offer storage report their resources to Server 5 for compiling a comprehensive File Allocation Table.
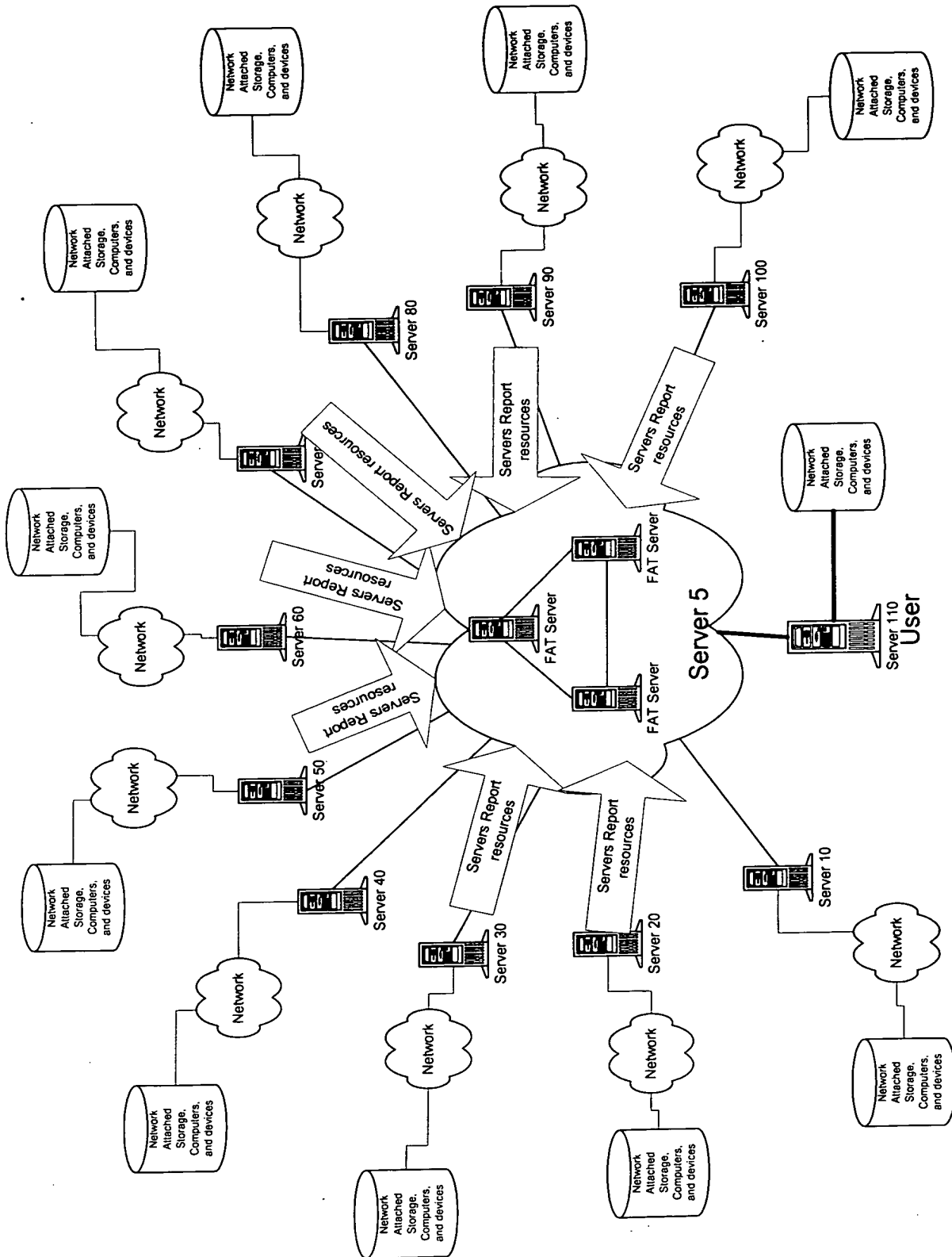
Figure 3

Vendor Servers wishing to offer storage report their resources to Server 5 for compiling a comprehensive File Allocation Table.
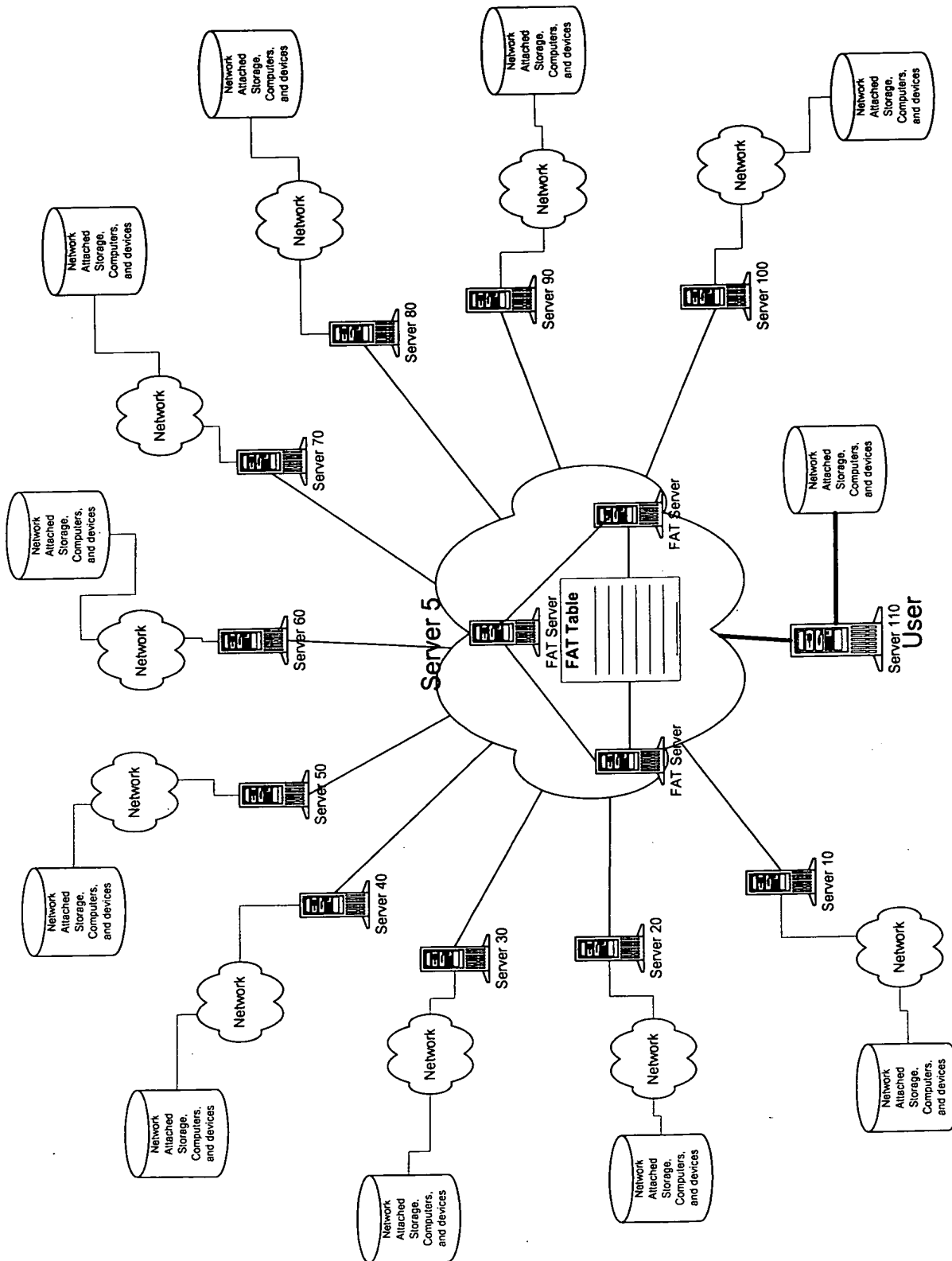
Figure 4

Server 5 forms comprehensive File Allocation Table identifying all storage available on the network, and the characteristics of each storage location.
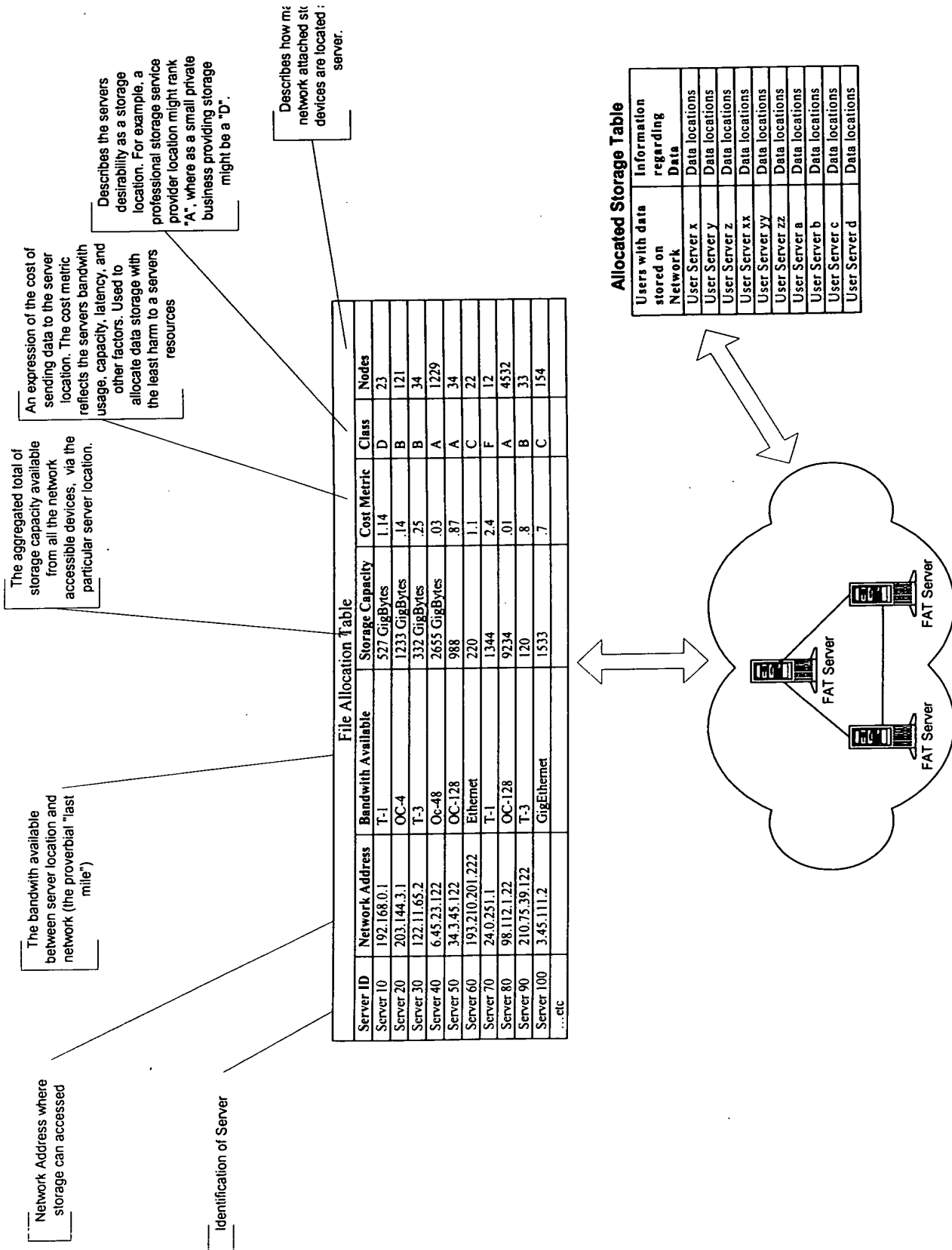
Network Address where storage can accessed

Identification of Server

The bandwith available between server location and network (the proverbial "last mile")

The aggregated total of storage capacity available from all the network accessible devices, via the particular server location.

An expression of the cost of sending data to the server location. The cost metric reflects the servers bandwith usage, capacity, latency, and other factors. Used to allocate data storage with the least harm to a servers resources

Describes the servers desirability as a storage location. For example, a professional storage service provider location might rank "A", where as a small private business providing storage might be a "D".

Describes how many network attached storage devices are located at server.

File Allocation Table

Server ID	Network Address	Bandwith Available	Storage Capacity	Cost Metric	Class	Nodes
Server 10	192.168.0.1	T-1	527 GigBytes	1.14	D	23
Server 20	203.144.3.1	OC-4	1233 GigBytes	.14	B	121
Server 30	122.11.65.2	T-3	332 GigBytes	.25	B	34
Server 40	6.45.23.122	Oc-48	2655 GigBytes	.03	A	1229
Server 50	34.3.45.122	OC-128	988	.87	A	34
Server 60	193.210.201.222	Ethernet	220	1.1	C	22
Server 70	24.0.251.1	T-1	1344	2.4	F	12
Server 80	98.112.1.22	OC-128	9234	.01	A	4532
Server 90	210.75.39.122	T-3	120	.8	B	33
Server 100	3.45.111.2	GigEthernet	1533	.7	C	154
...etc						

Allocated Storage Table

Users with data stored on Network	Information regarding Data
User Server x	Data locations
User Server y	Data locations
User Server z	Data locations
User Server xx	Data locations
User Server yy	Data locations
User Server zz	Data locations
User Server a	Data locations
User Server b	Data locations
User Server c	Data locations
User Server d	Data locations

FAT Server

FAT Server

FAT Server

Server 5

Figure 4a

File allocation Table is formed, using information reported from Servers 10-100, servers also hold tables of data allocated and stored on the system.
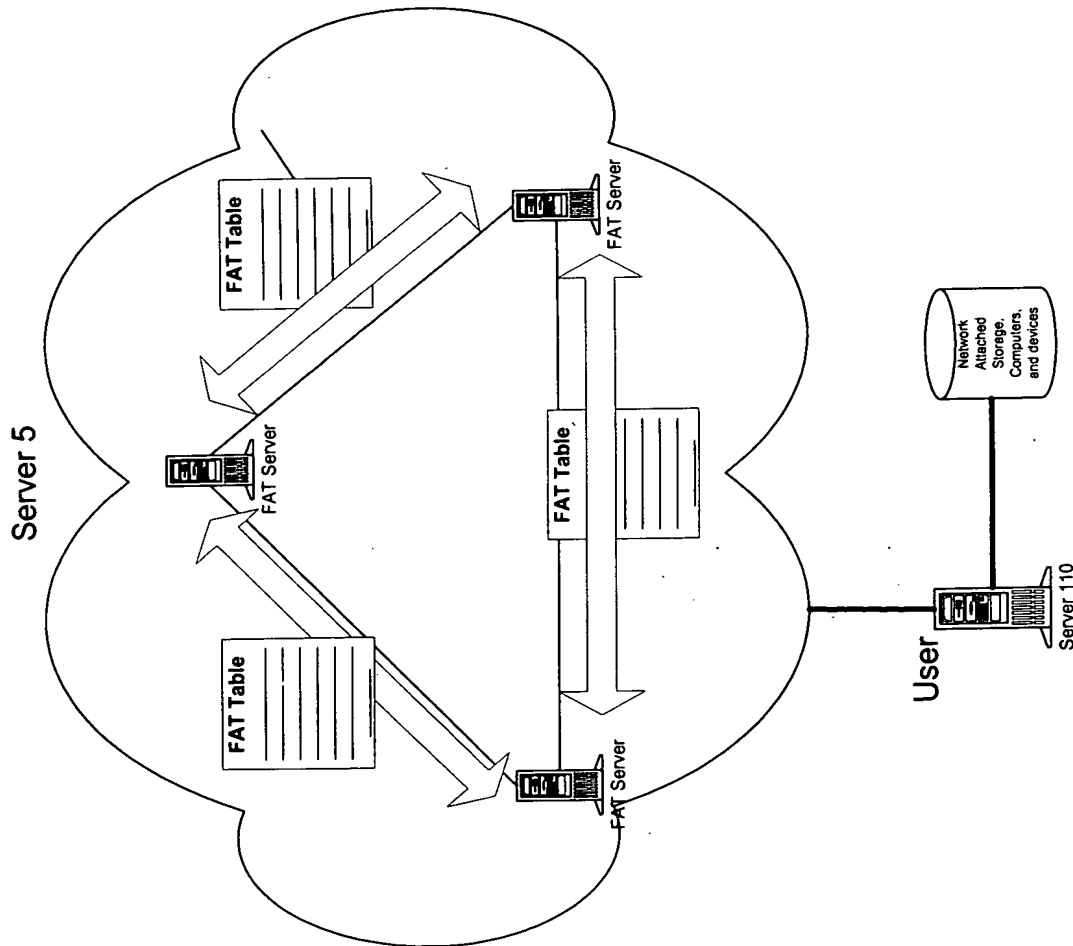
Figure 4b

Server 5 consists of several computing systems, for redundancy and availability of the FAT tables. The FAT tables are therefore mirrored on each individual FAT server. Each individual FAT server will have the same data.
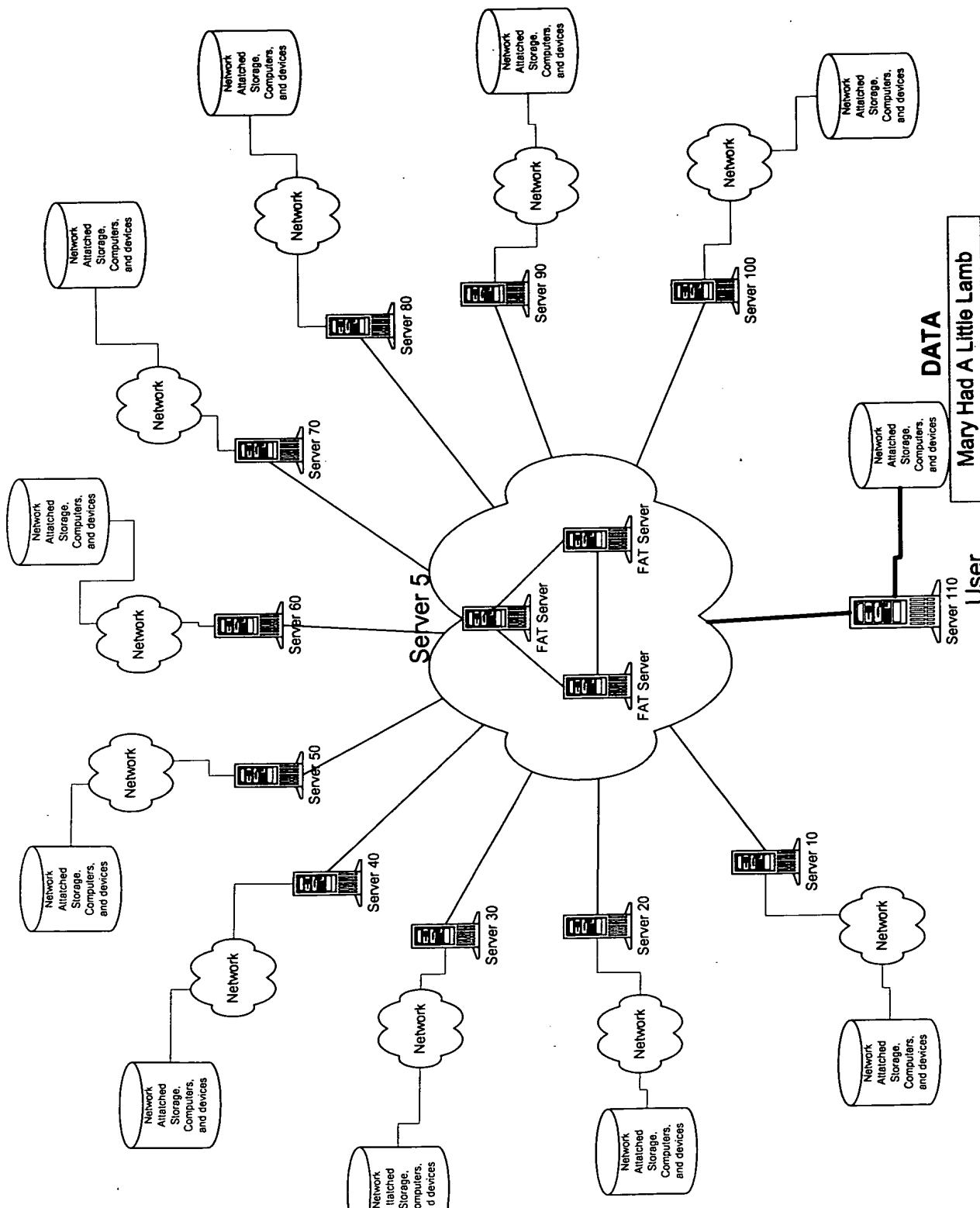
Figure 5

User, Server 110, requires storage services, either for itself, or for a network attatched device on the Server 110 network.
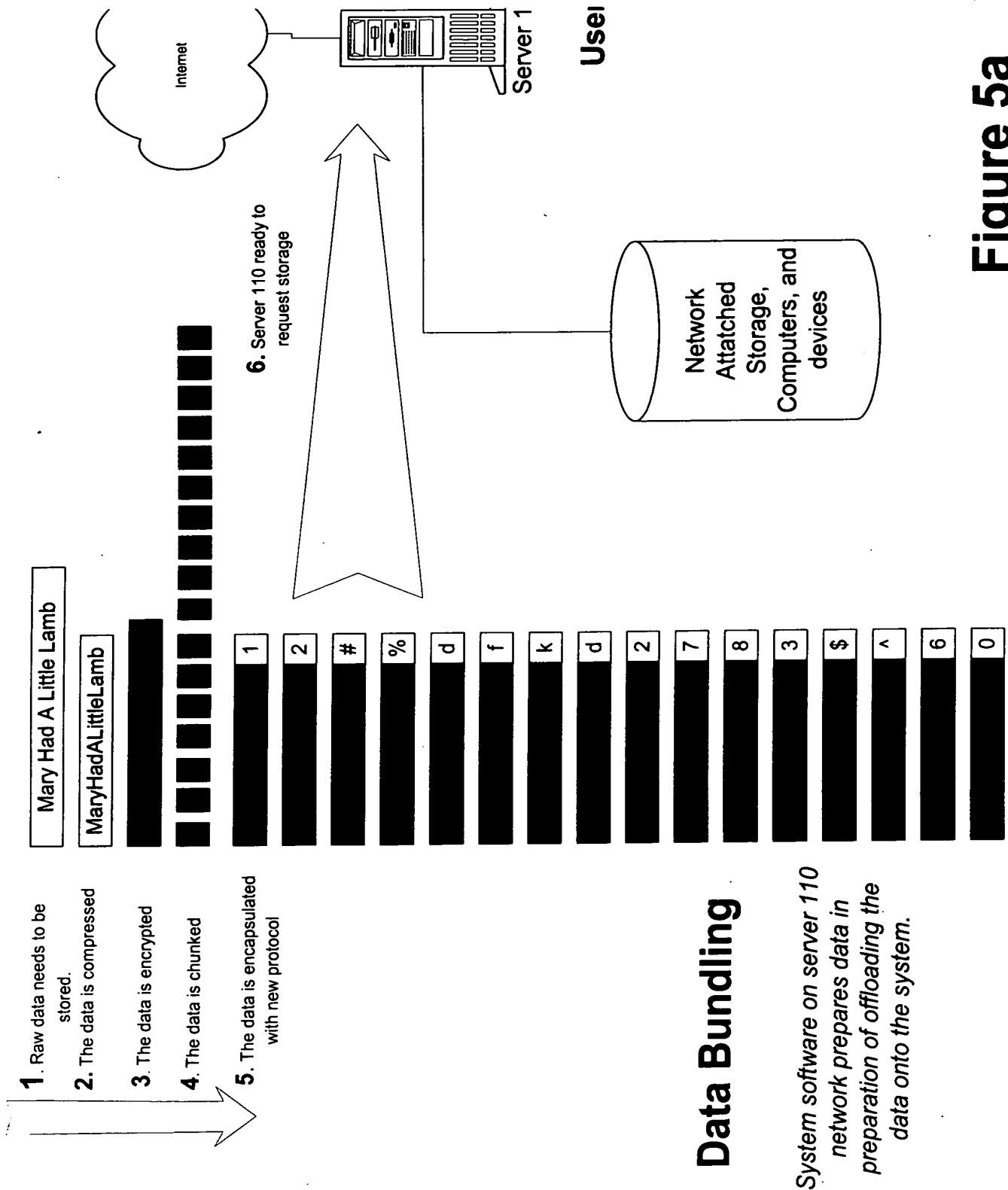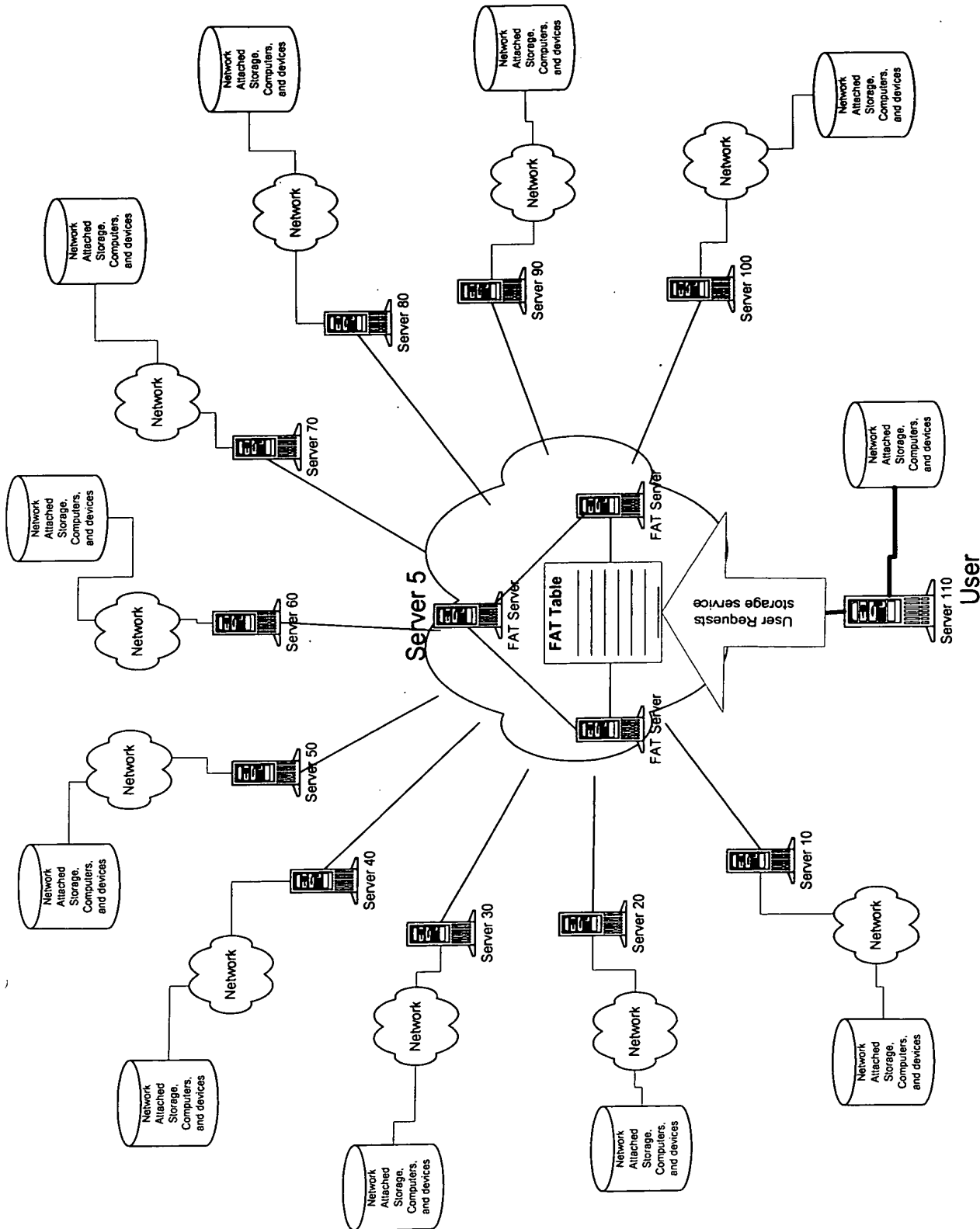
Figure 5a
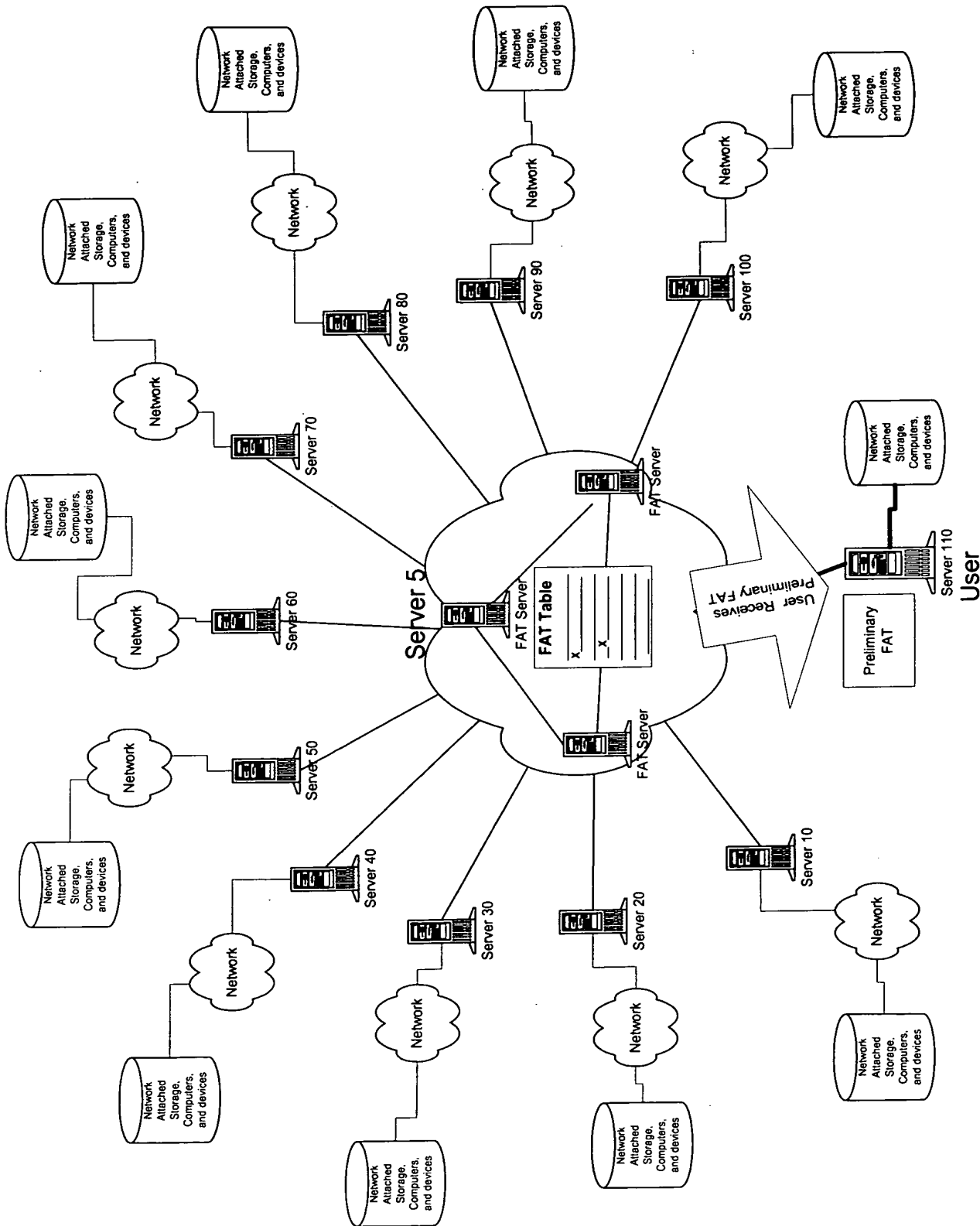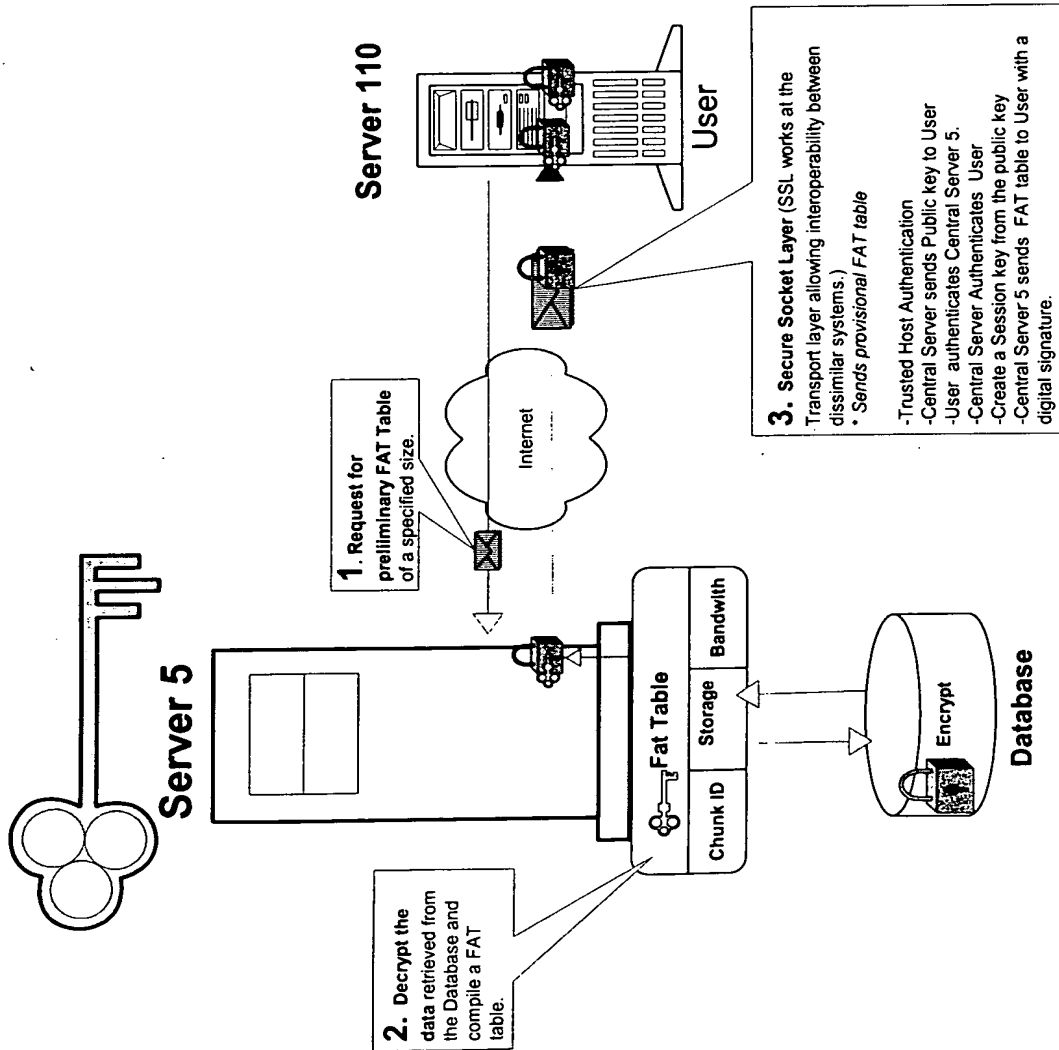
Figure 6

User requests storage service, requires a portion of the storage found in the File Allocation Table found on Server 5

Figure

Server 5, the File Allocation Servers, sends Server 110 a provisional FAT table, allocating storage space. Server 5 marks on the central FAT which records it has released to server 110, and locks those storage records so that no other user can use those storage resources.
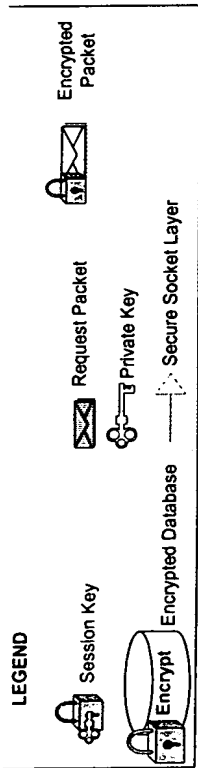
Figure 7a

LEGEND

Session Key

Request Packet

Secure Socket Layer

Private Key

Encrypted Packet

Encrypted Database

Encrypt

Server 5

Server 110

User

Internet

1. Request for preliminary FAT Table of a specified size.

2. Decrypt the data retrieved from the Database and compile a FAT table.

Fat Table

Chunk ID | Storage | Bandwith

Database

Encrypt

3. Secure Socket Layer (SSL works at the Transport layer allowing interoperability between dissimilar systems.)
• *Sends provisional FAT table*

-Trusted Host Authentication
-Central Server sends Public key to User
-User authenticates Central Server 5.
-Central Server Authenticates User
-Create a Session key from the public key
-Central Server 5 sends FAT table to User with a digital signature.

User requests storage service, requires a portion of the storage found in the File Allocation Table found on Server 5

Data on or accessible to User Server 110, to be stored on system

1 2 # % d f k d 2 7 8 3 $ ^ 6 0
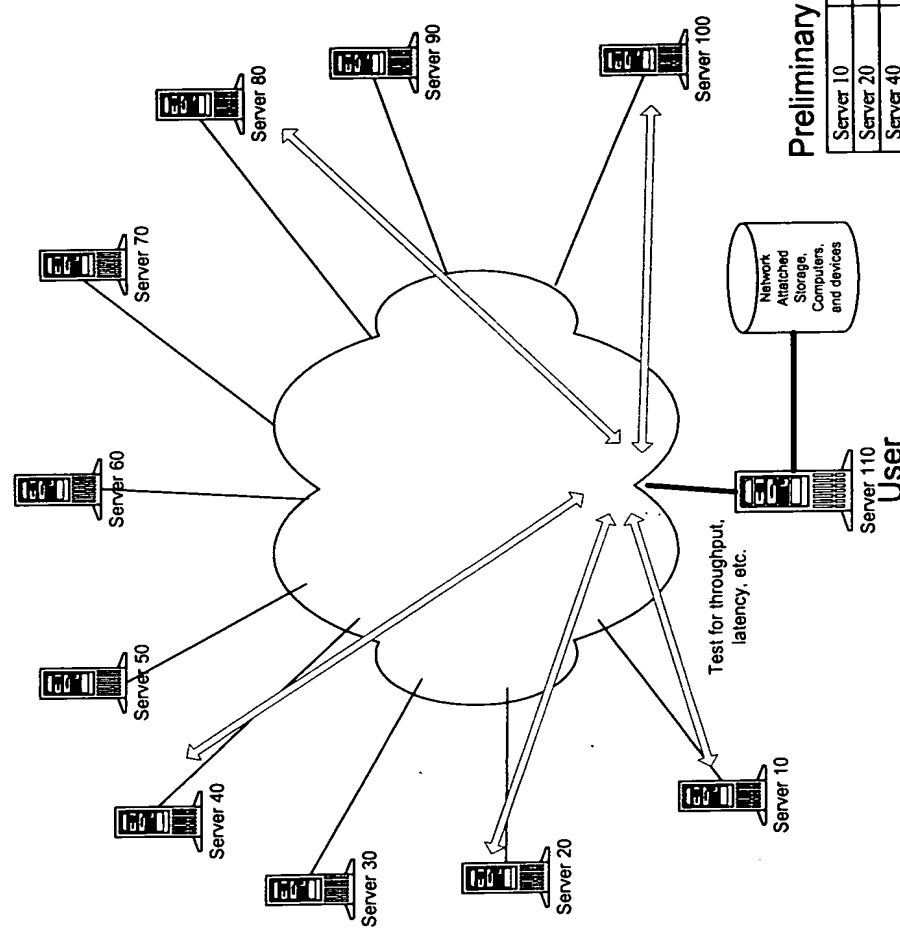
Preliminary FAT Table

Server 10	10 Gigabytes
Server 20	66 Gigabytes
Server 40	15 Gigabytes
Server 60	22 Gigabytes
Server 80	45 Gigabytes
Server 100	22 Gigabytes

Server 80

Server 90

Server 100

Server 70

Network Attatched Storage, Computers, and devices

Server 60

Server 110
User

Server 50

Test for throughput, latency, etc.

Server 40

Server 10

Server 30

Server 20

Figure 8

The user, Server 110, searches for an optimum path to offload data. Server 110 checks each potential location in the provisional FAT table paths for optimimu path; latency, hop count, availability, etc.

Figure 9

Server 110 discards certain server locations as undesireable for offloading.
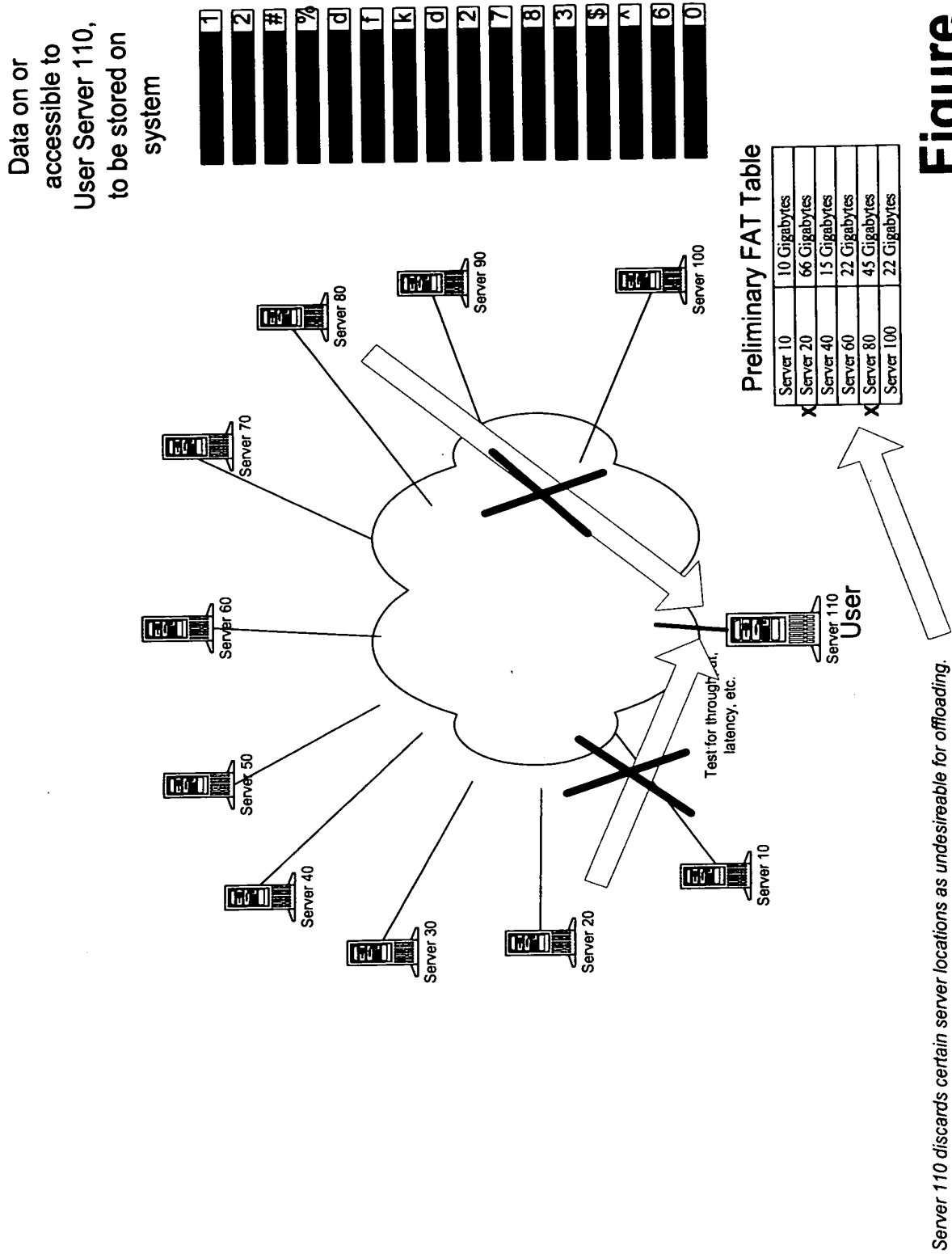
Data on or accessible to User Server 110, to be stored on system-- Headers are attached to each data chunk
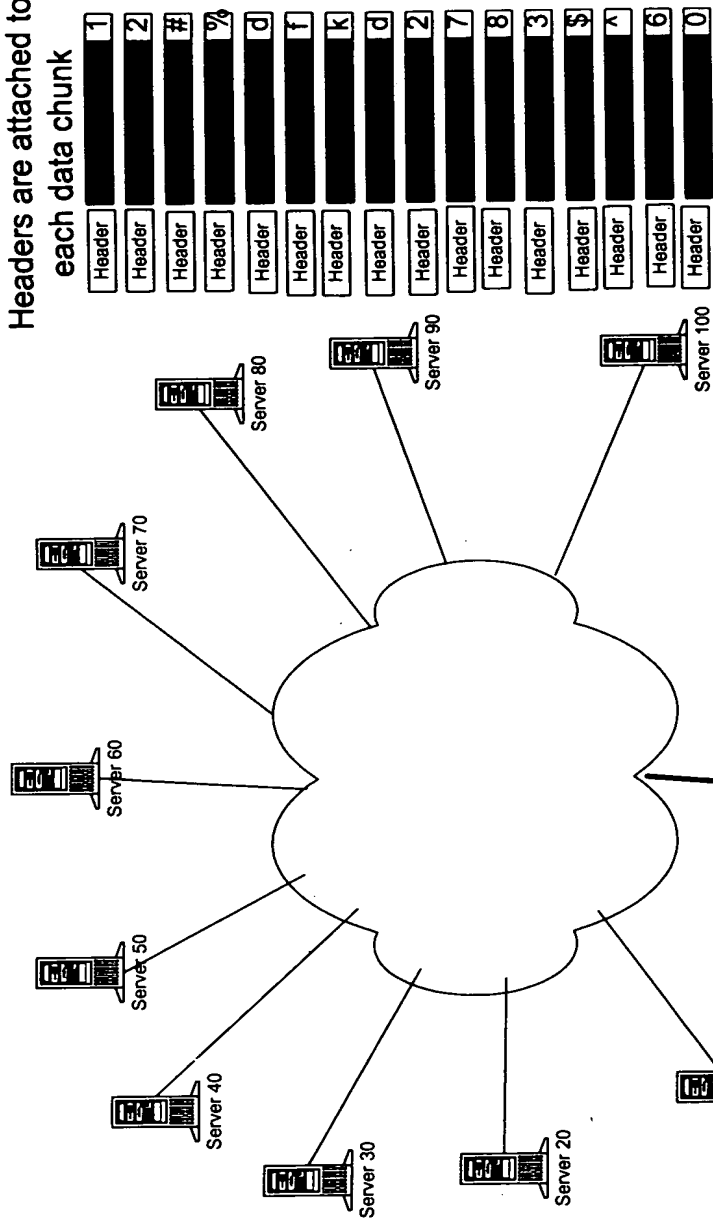
		Header	1
		Header	2
		Header	#
		Header	%
		Header	d
		Header	f
		Header	k
		Header	d
		Header	2
		Header	7
		Header	8
		Header	3
		Header	$
		Header	<
		Header	6
		Header	0

Preliminary FAT Table

	Server 10	10 Gigabytes
	Server 20	66 Gigabytes
X	Server 40	15 Gigabytes
	Server 60	22 Gigabytes
X	Server 80	45 Gigabytes
	Server 100	22 Gigabytes

Server 80

Server 90

Server 100

Server 70

Server 60

Server 50

Server 40

Server 30

Server 20

Server 10

Server 110
User

Headers are attached to the data chunks, individually. The header identifies that the data belongs to Server 110, where the data is to be sent, where the data is to be resent for duplication, and how much the data needs to be chunked further at each vendor server location to further protect the data.

Figure 10

Data on or accessible to User Server 110, to be stored on system

Header	1
Header	2
Header	#
Header	%
Header	d
Header	f
Header	k
Header	d
Header	2
Header	7
Header	8
Header	3
Header	$
Header	x

Server 80

Server 90

Server 100

Server 70

Server 60

Server 50

Server 40

Server 30

Server 20

Server 10

Server 110

User

Header 6

Header 0

Preliminary FAT Table

	Server 10	10 Gigabytes
X	Server 20	66 Gigabytes
	Server 40	15 Gigabytes
	Server 60	22 Gigabytes
X	Server 80	45 Gigabytes
	Server 100	22 Gigabytes

Figure 11

Server 110 sends data to servers for storage.

Figure 12

Figure 12a

Other Vendor Servers

A

Other Vendor Servers

Other Vendor Servers

Porvisional Fat Table

Server 110

Other Vendor Servers

I am receiving data
Validate the data.
Update the Server
110 FAT table

Other Vendor Servers

Other Vendor Servers

I am Sending a copy
of the Data

Other Vendor Servers

Server 40

Figure 13a

User

Server 110

Other Vendor Server

Other Vendor Server

Network

Vendor

Server 40

Network

Network Accessible Device

Physical Storage

Network Accessible Device

Physical Storage

Network Accessible Device

Physical Storage

Network Accessible Device

Physical Storage

1. Header is examined for instructions
A. Header

2. Header is examined for instructions
A. Header

3. Header instructs server 40 how much to re-chunk the data

4. Data is more finely chunked for distribution on LAN

Data is received from Server 110 by Server 40, and is prepared for distribution on the server 40 network.

Figure 13b

5. Data is more finely chunked by Server 40 for delivery on LAN

6. Data is encapsulated by Server 40 with protocol for retreival, identification, and distribution, etc.

Server 40 reads in the header the instructions as to how much to re-chunk the data before distribution on the Server 40 network. Server 40 will rechunk the data at least as much as the header requests.

Figure 13c

7. Data is distributed by Server 40 to network attached devices for storage

8. Data is stored on network accessable devices

Server 40 sends server 110's data to the network accessable devices for storage.

Figure 13

Network accessable devices on the server 40 network respond to server 40 with a data validation message, confirming that the data was successfully stored. If no data validation message returns for a particular data chunk, the chunk is either resent or sent to a different device on the server 40 network. Server 40 compiles and stores local File allocation table for the data stored on the Server 40 network

Figure 13

Vendor

Network

Server 40

Network

Physical Storage

Network Accessable Device

Network Accessable Device

Network Accessable Device

Network Accessable Device

Physical Storage

Physical Storage

Physical Storage

Physical Storage
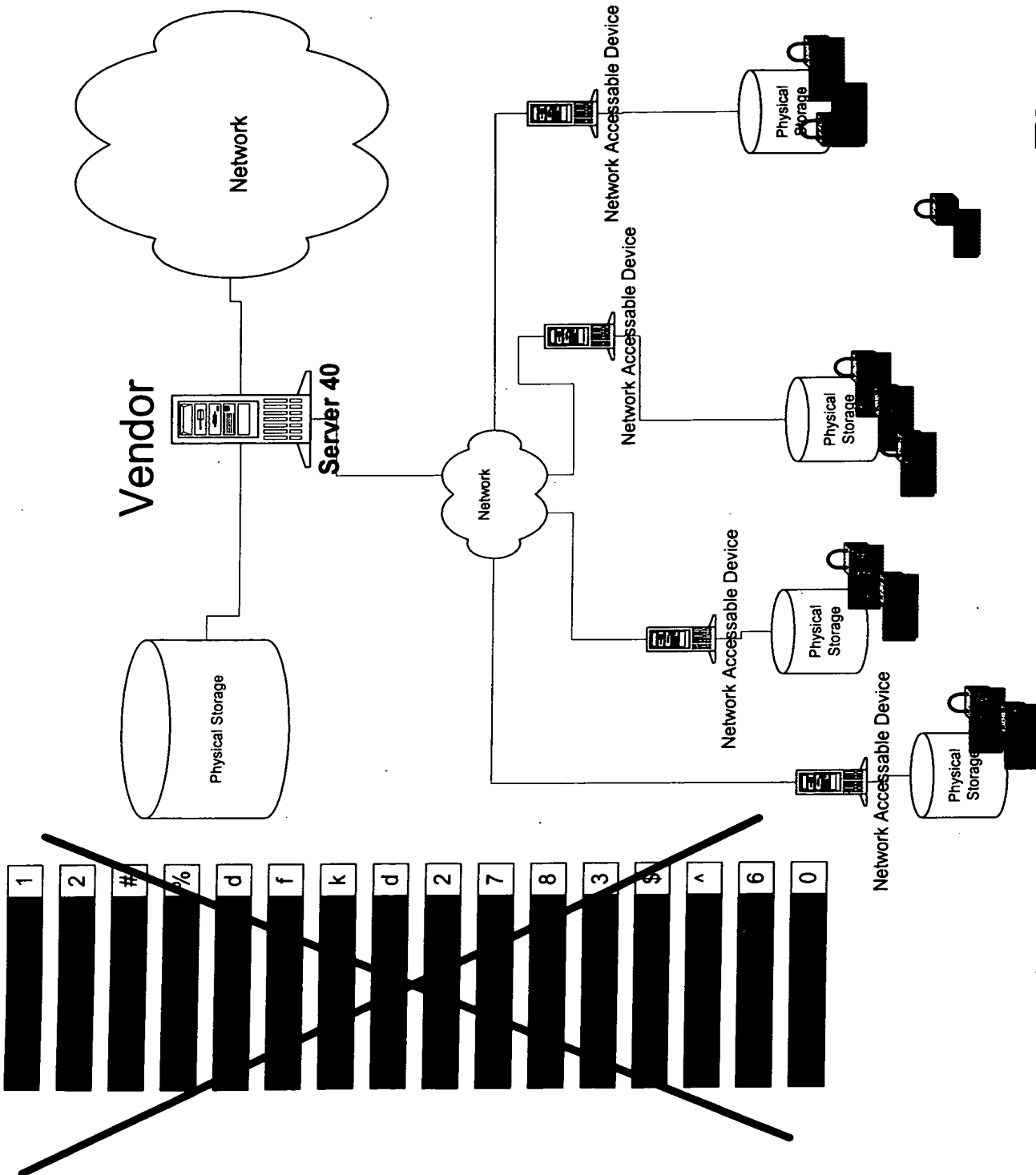
Server 40 receives validation messages from Network accessable devices, and is free to erase the Server 40 local copy of the data. Server 40 maintains a record of where the data resides.

Preliminary FAT Table

Server 10	10 Gigabytes
Server 20	66 Gigabytes
Server 40	15 Gigabytes
Server 60	22 Gigabytes
Server 80	45 Gigabytes
Server 100	22 Gigabytes
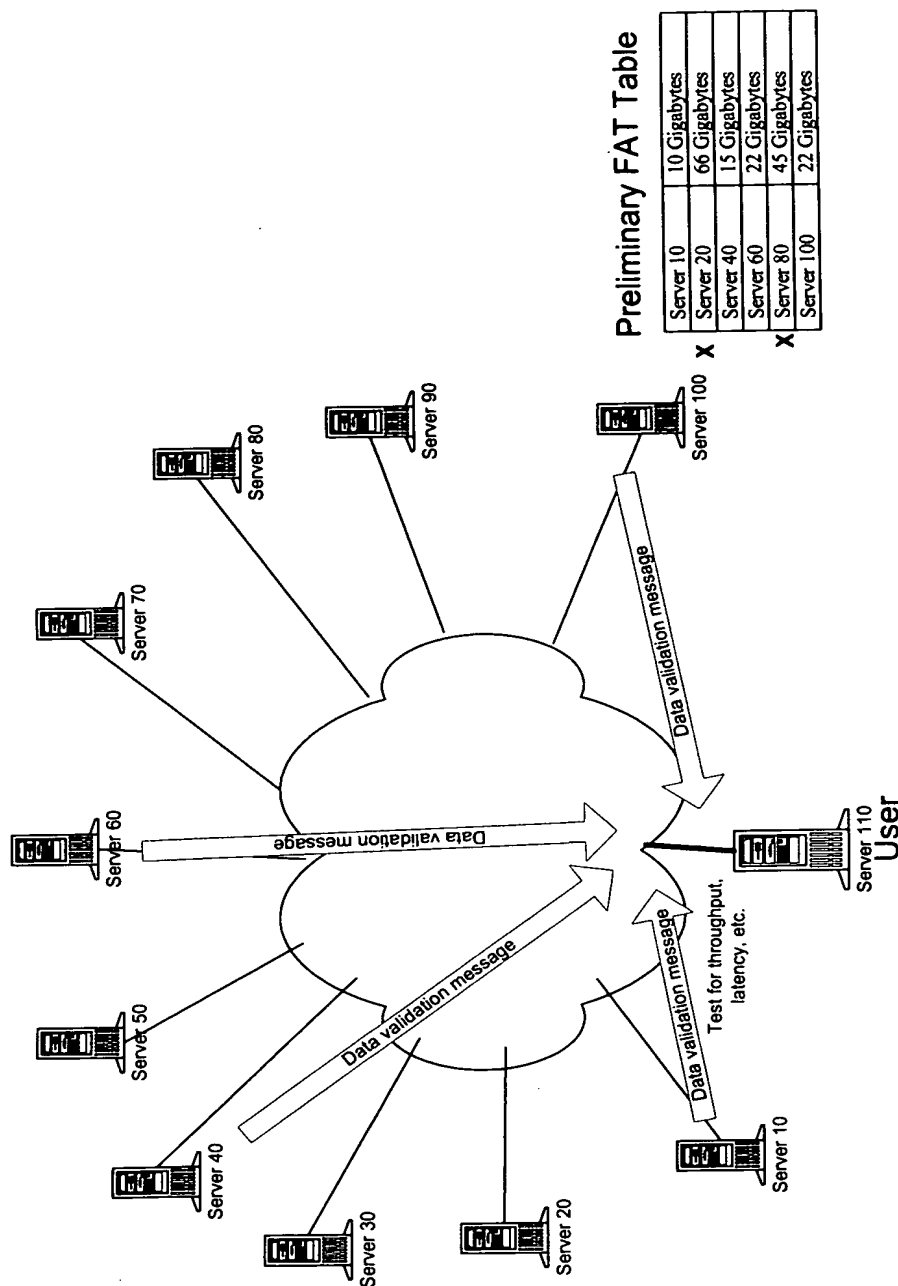
Figure 14

Servers providing storage report back to user to validate that the data was stored successfully. If unsuccessful, or a vendor servers is not heard from, then the data will be resent to a new location, and the location will be marked as unused on the preliminary FAT table.
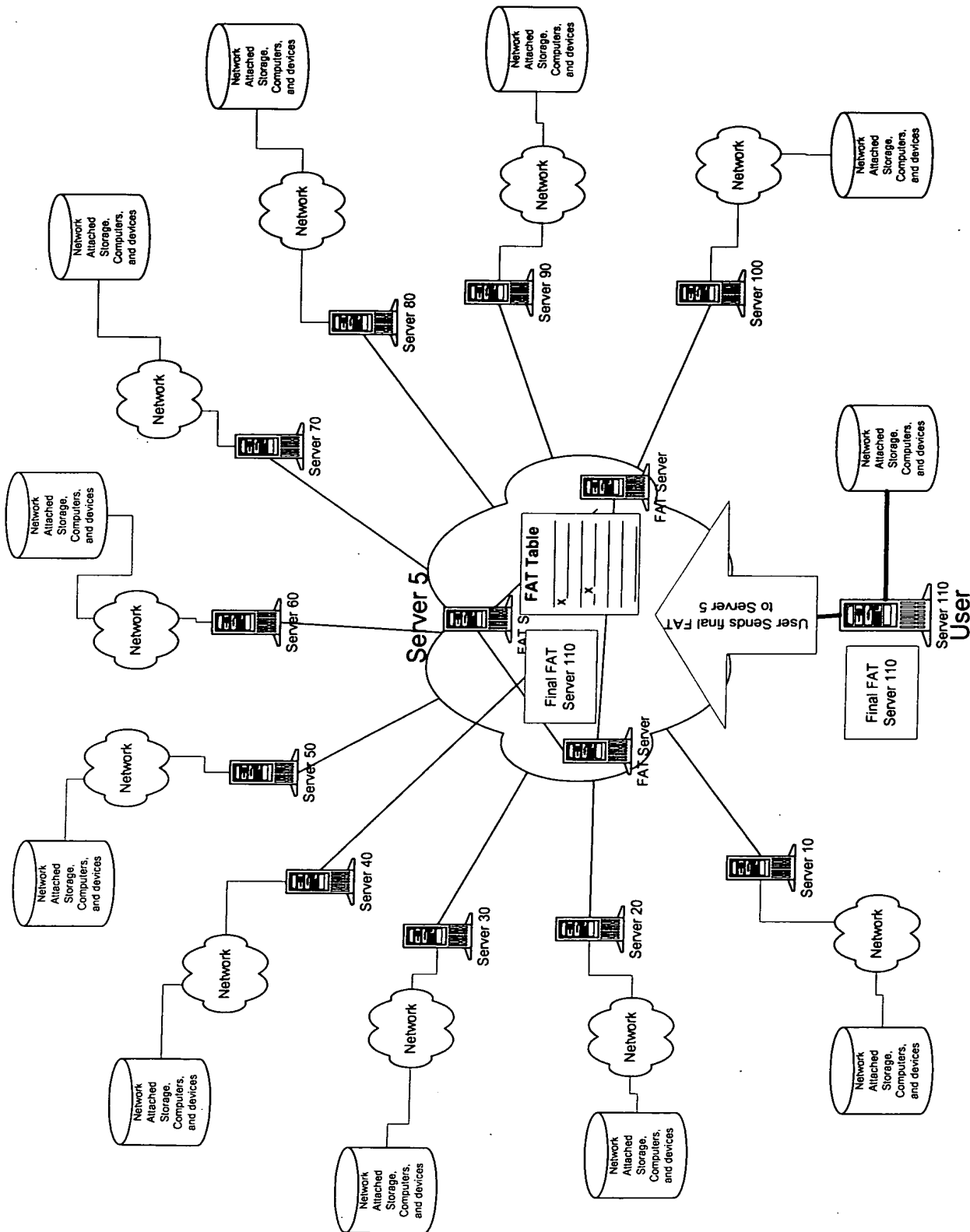
Figure 15

Server 110 compiles a final FAT, identifying where the data finally was stored successfully. Server 110 sends the final FAT table to Server 5 for storage for when Server 110 wishes to download the data back to Server 110 at a later time. Server 5 checks the final FAT, and releases as usable by other Users any location on the Final FAT that Server 110 did not use. Server 5 marks as "used" any server resources allocated and used by Server 110

Figure 15a

View of Server 110 data, after offload, if stored over the internet
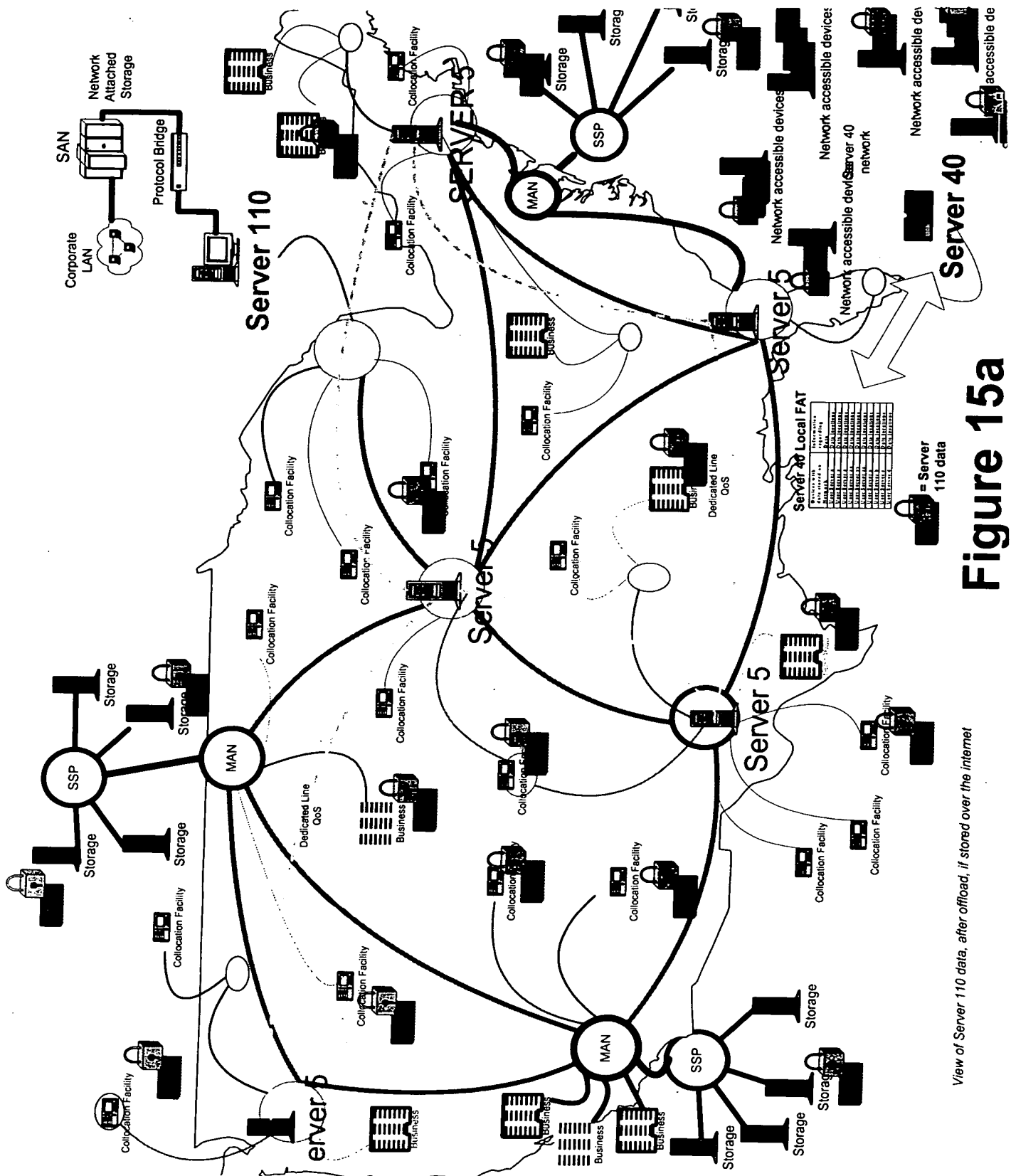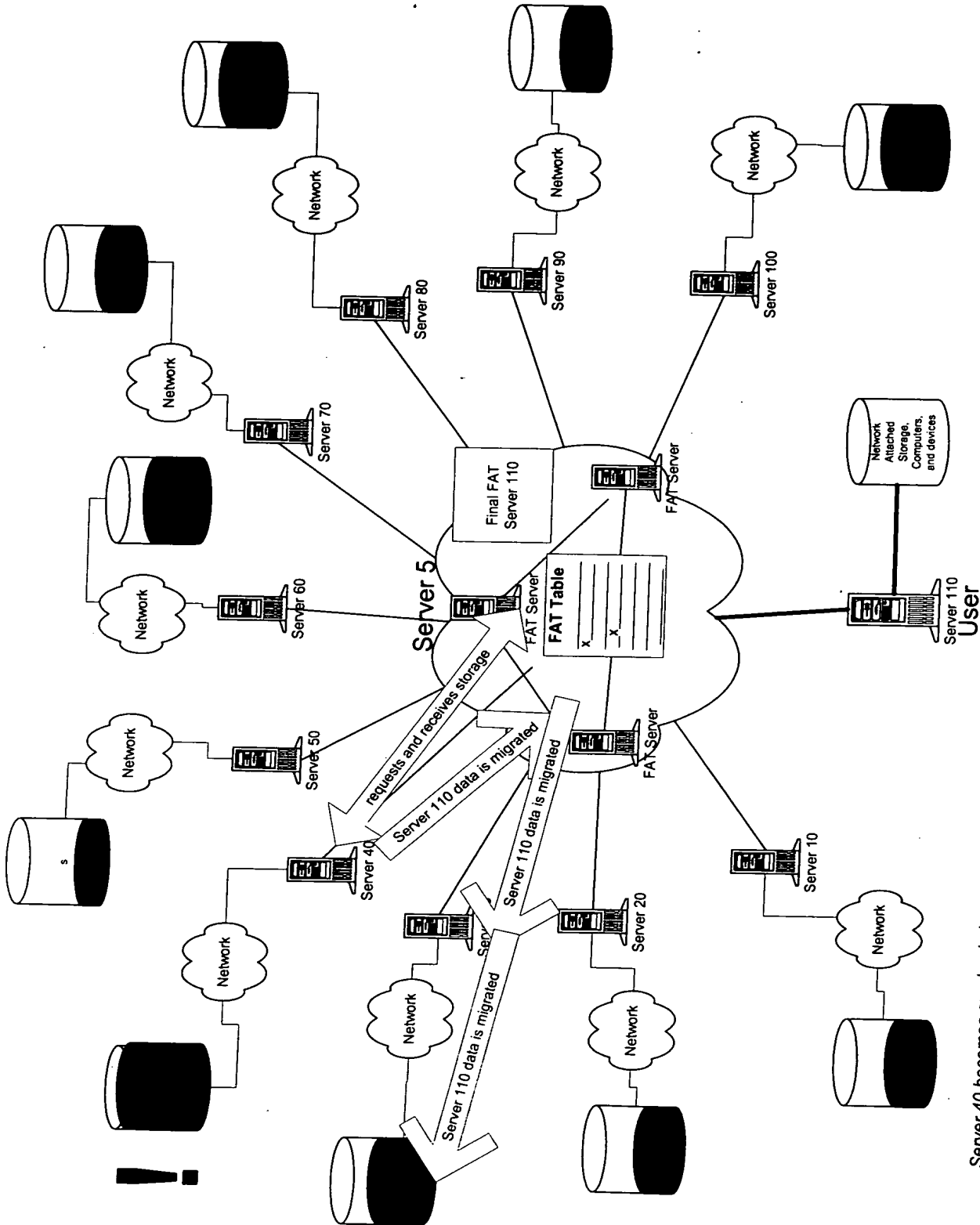
Figure 15b

Server 40 becomes overloaded, and must migrate server 110 data, so server 40 requests storage from server 5. Server 5 allocates storage from the FAT table. After the data has migrated and is validated, Server 5 updates the final fat table for server 110.
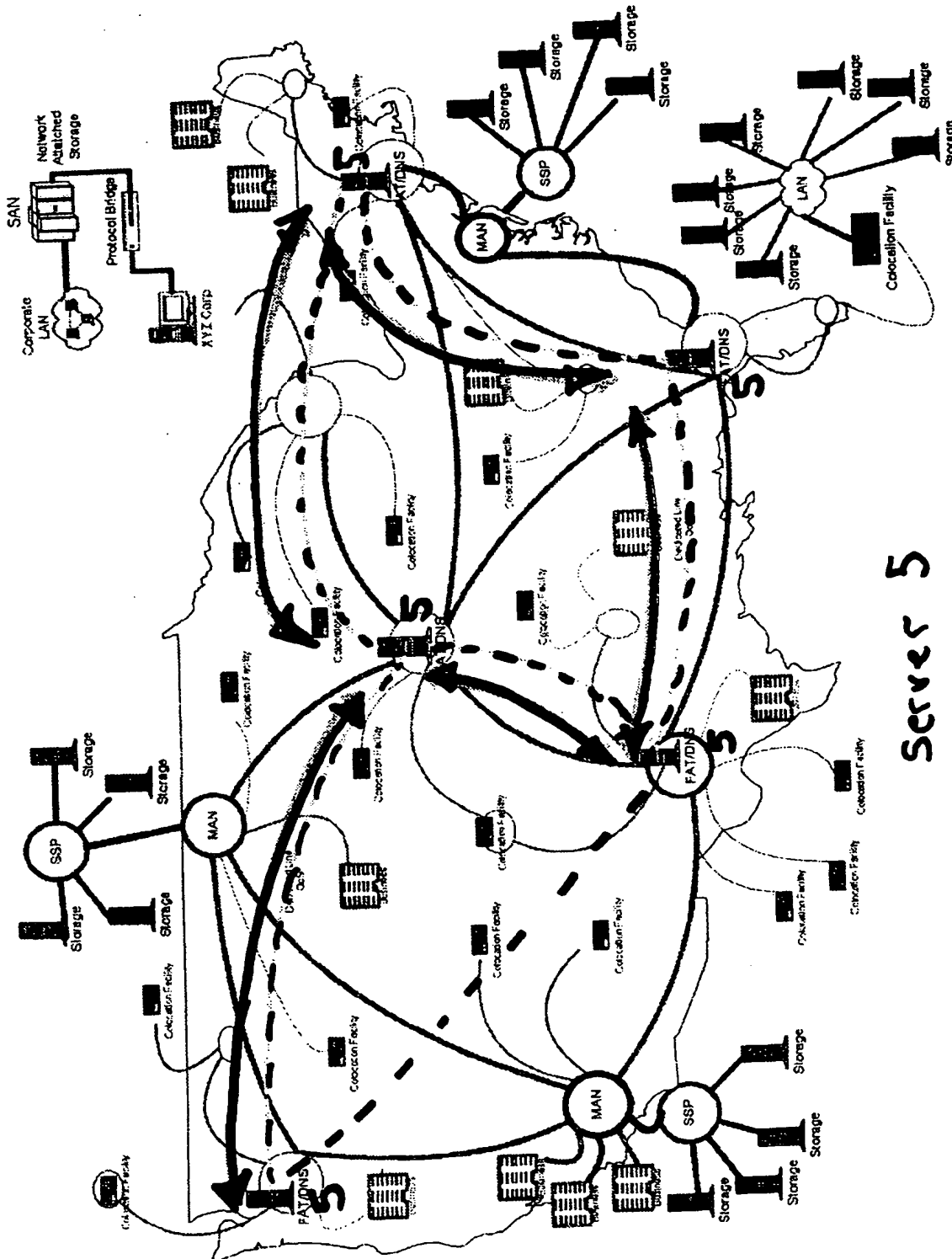
Figure 15c

Server 5

------ = Private Network
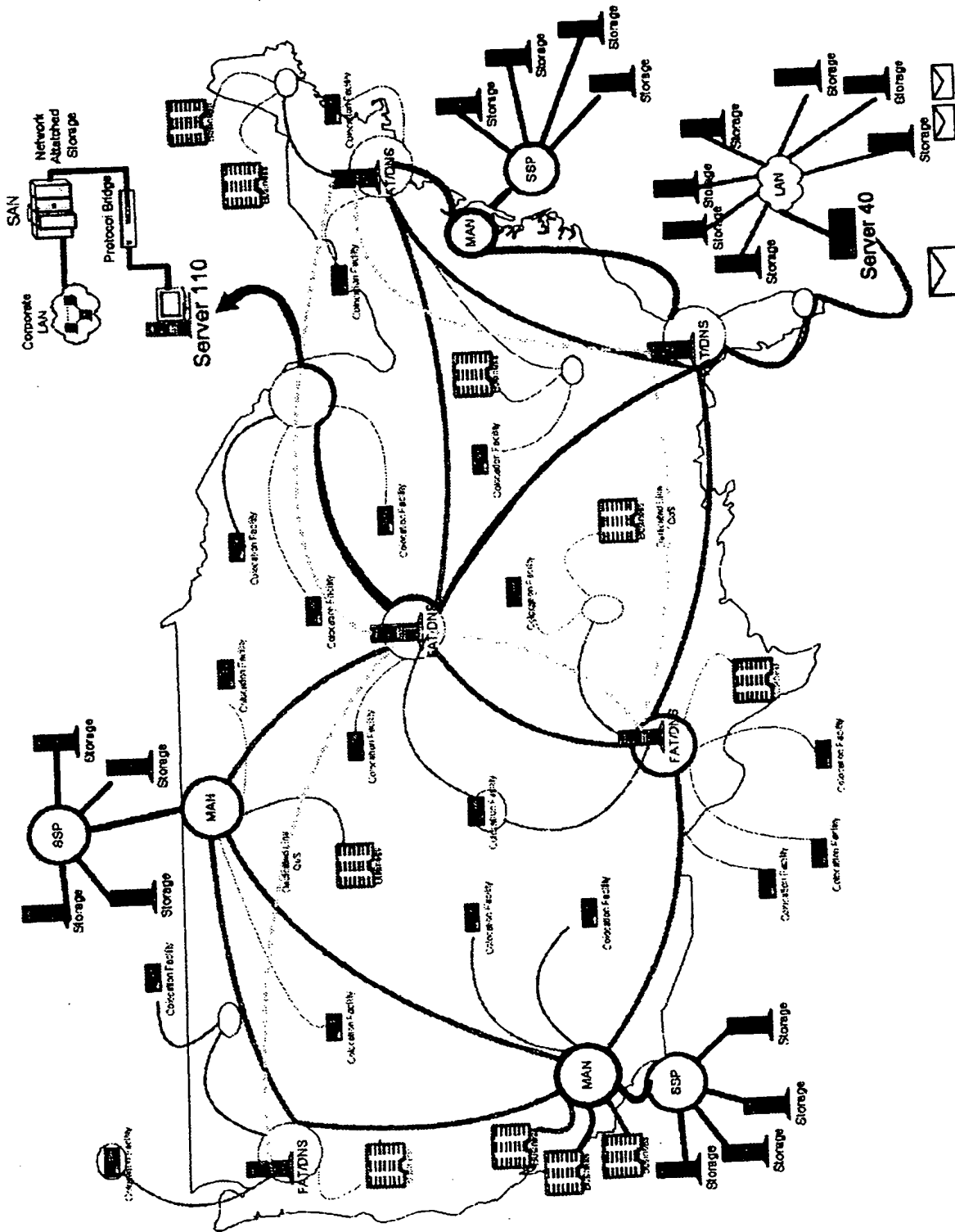
Figure 15d
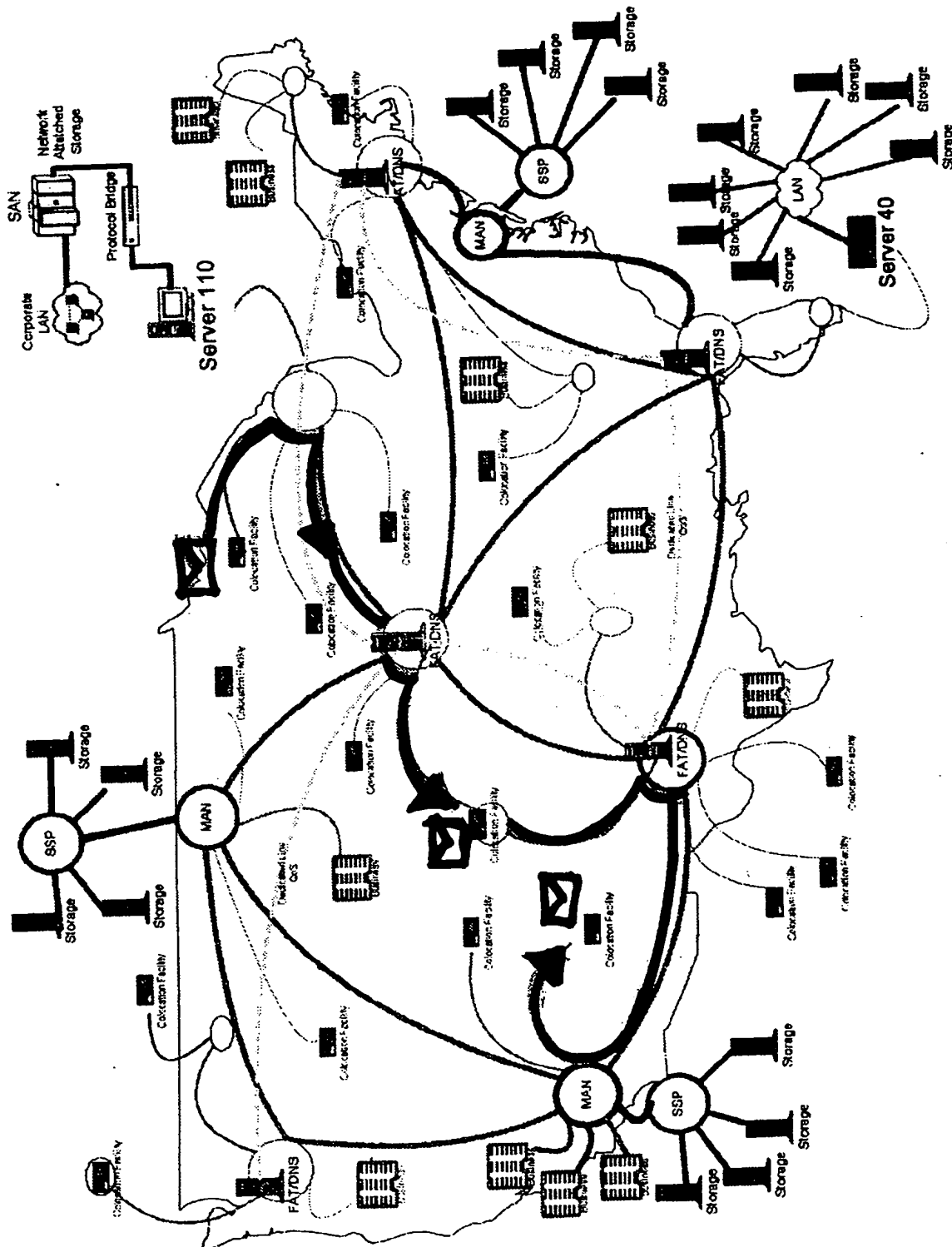
Figure 15e
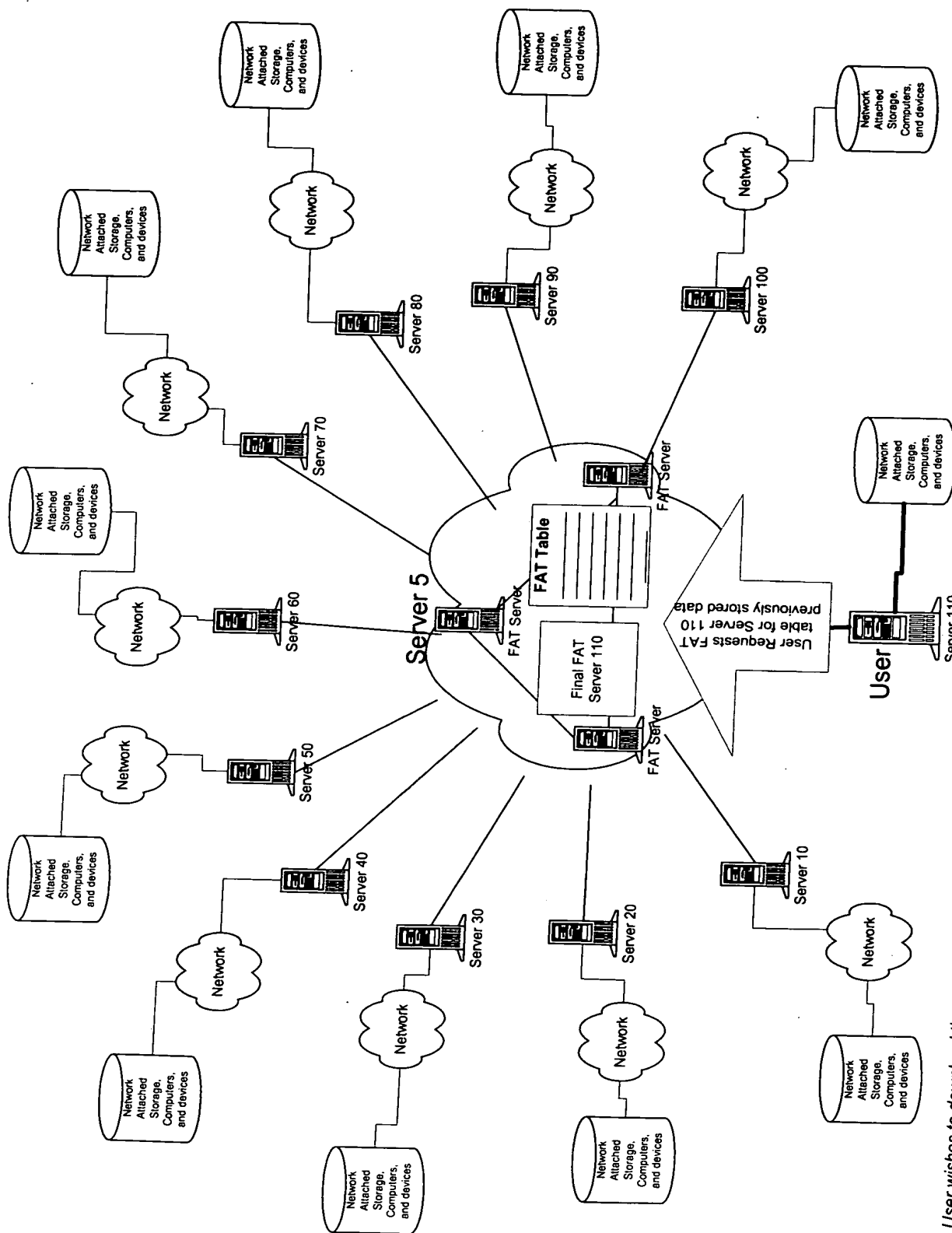
Figure 16

User wishes to download the previously stored data, which might have migrated since it was offloaded to various servers. User therefore logs onto the Server 5 and requests the authoritative FAT table that indicates where the Server 110 data resides. In the period since server 110 offloaded the data, the data might have migrated due to overloaded conditions on a particular vendor service, in which case the overloaded server would request a storage location from server 5 (as previously shown), and would have moved the data.
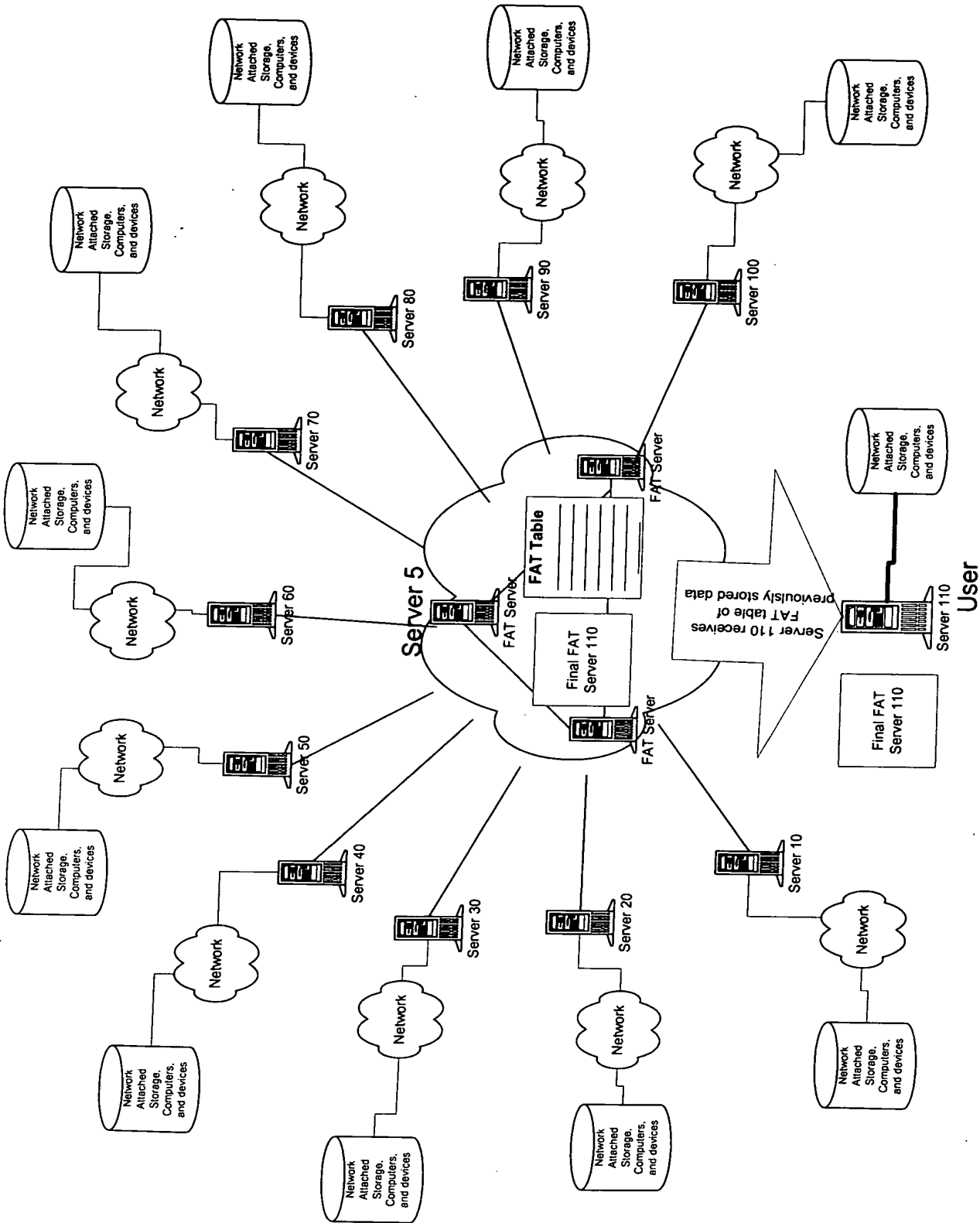
Figure 17

Server 110 Sends for and receives its FAT table for all locations of its data, even the duplicate locations for each data chunk.

Figure 18
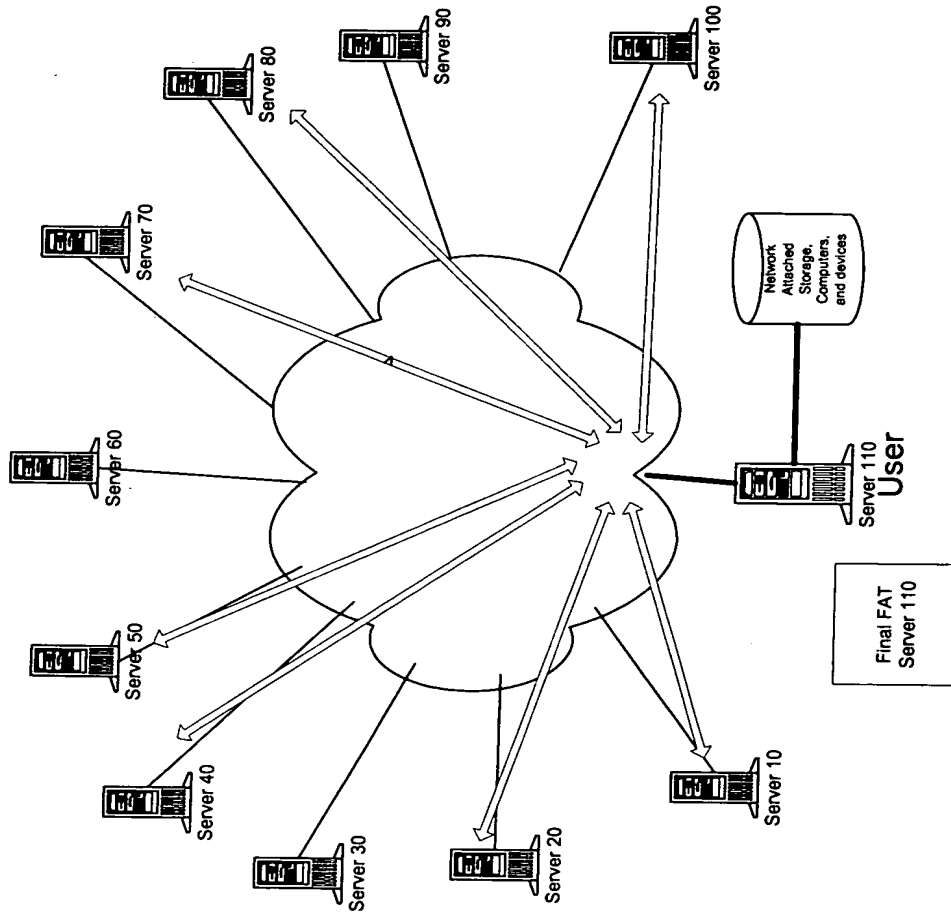
The user, Server 110, searches for an optimum path to download the data.
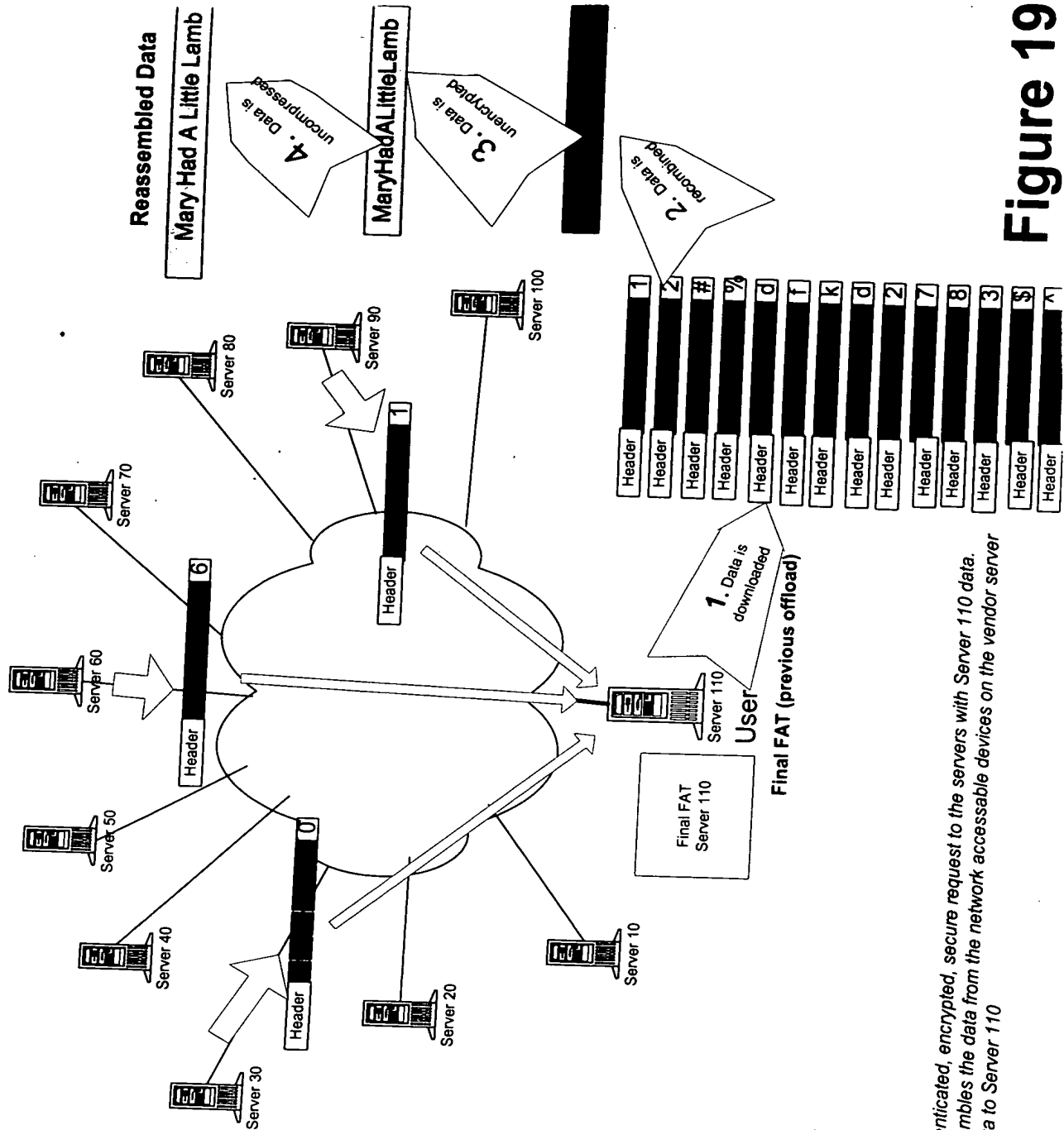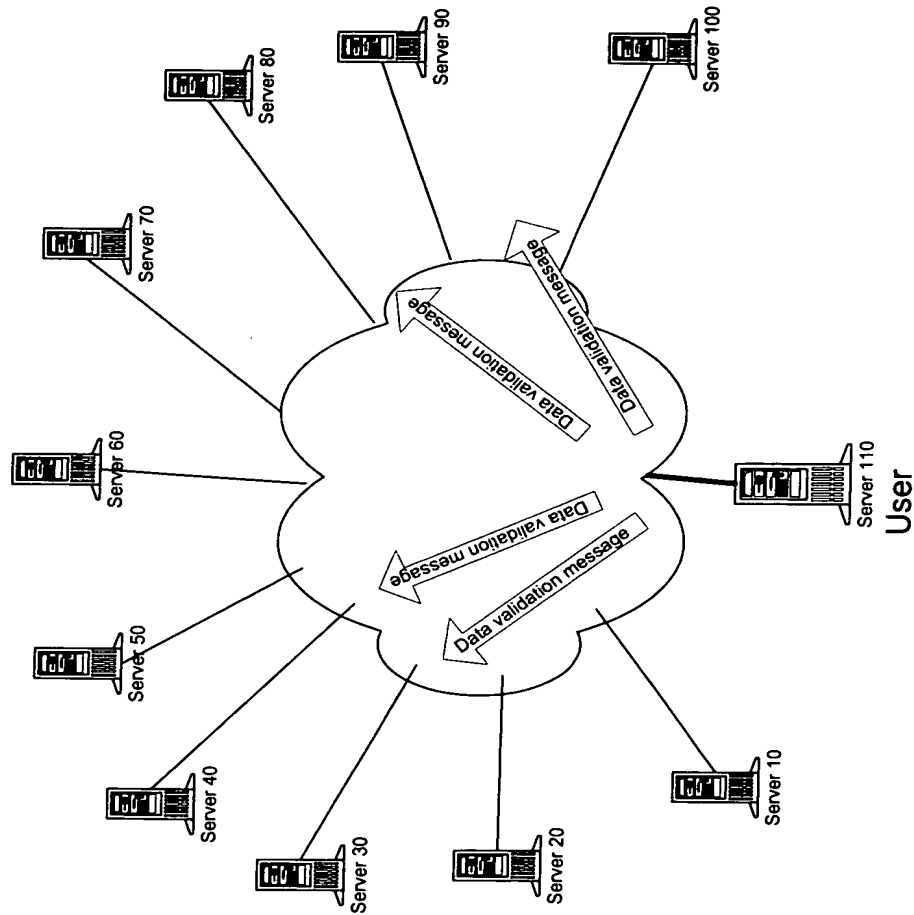
Figure 19

Figure 20

Server 110 sends a data validation message to each of the vendor servers from which it successfully downloaded
Server 110 data, confirming that the data was received.

Title. SYSTEM AND METHOD FOR STORING DATA
ntor: Erik PETERSEN
Application No.: 09/884,437
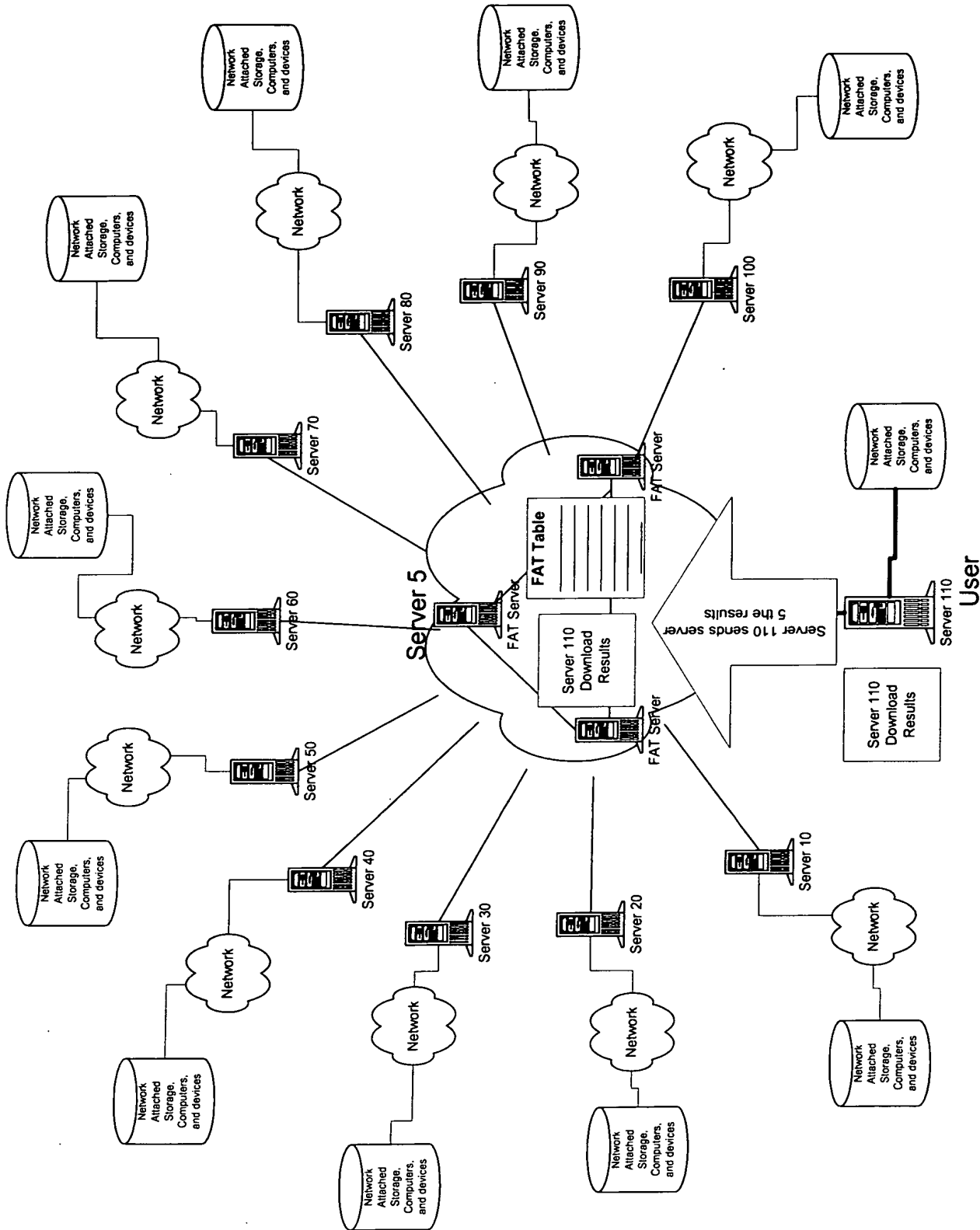Docket No.: 459042000300

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Figure 21

Server 110 sends Server 5 the results of its download so that server 5 can reallocate the storage resources previously used by server 110.
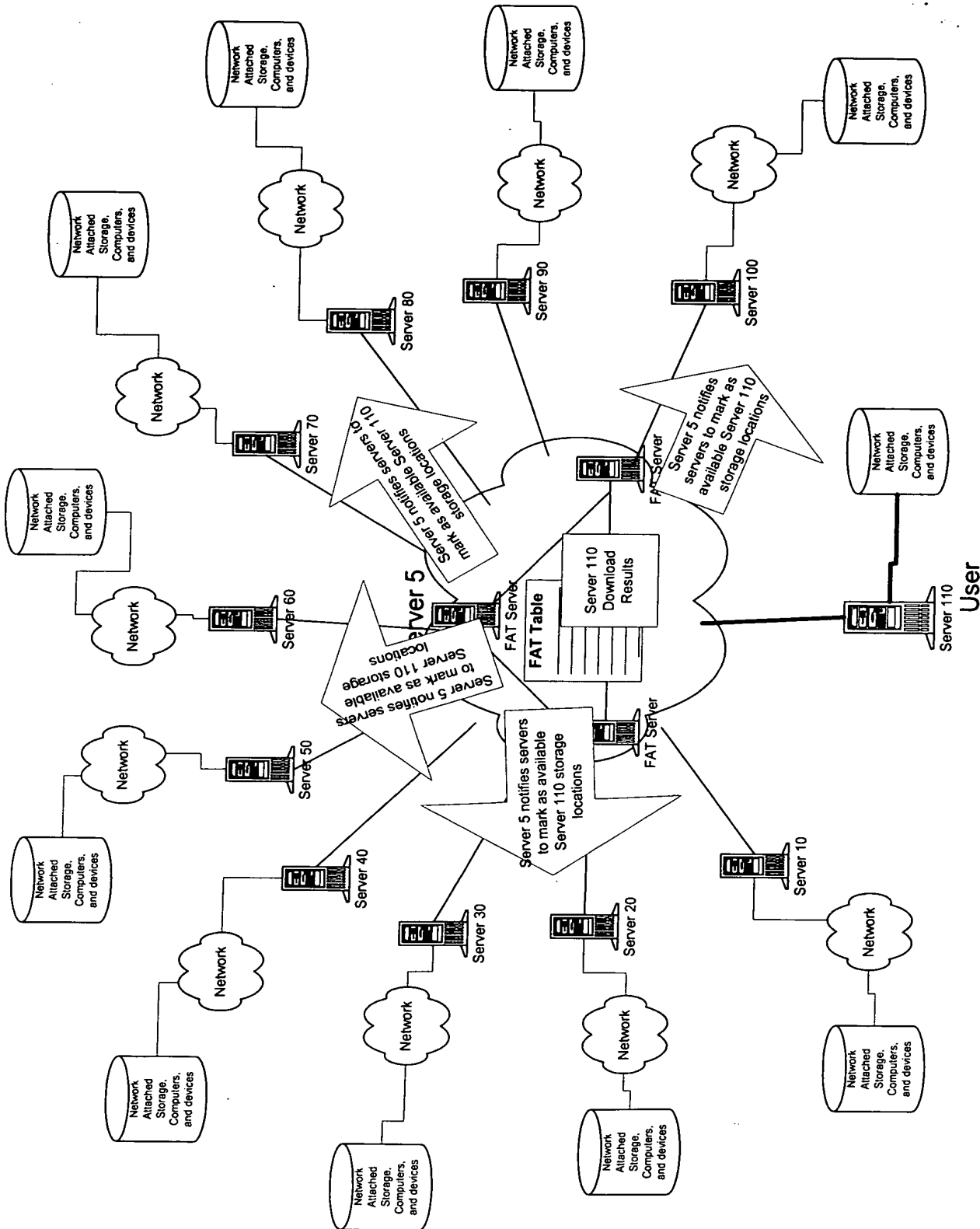
Figure 22

Server 5 notifies the vendor servers that had stored the server 110 data, indicating that the vendor servers can erase the resources previously used by server 110.